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The Welsh Engineers' and Founders' Association
The Foundry Trades' Equipment and Supplies Association

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British Cast Iron Research Association (affiliated).

Ministerial Co-operation

It is gratifying that the appropriate department of Ministry of Supply has reinforced our editorial on the subject of co-operation by stressing that there exist a number of easily tapped sources of technical information. Our correspondent "A.M.I.B.F.," like many others, no doubt expected that the methods he wished to have divulged to him would be given unofficially by the "man in the next foundry." Ninety-nine times out of a hundred this system would be free from objection, but seekers after knowledge must take into consideration the other fellow's view-point. It may be possible that the "other fellow" has quite correctly had it impressed upon him that the work upon which he is engaged is of a confidential character. It is our policy periodically to stress the number and variety of sources of information available to the members of the foundry industry. They can be approached with the utmost confidence by either a firm or an individual. If, however, there be the slightest doubt as to the propriety of an approach, then an inquiry to the appropriate Ministry or Control as a preliminary is called for. These sources of information include, *inter alia*, the Technical Advisory Panel to the Director for Iron Castings; the Institute of British Foundrymen; the British Cast Iron Research Association; the research and development departments established by the manufacturers of nickel, aluminium, copper and lead; and, finally, ourselves. Where armaments are concerned, we put inquirers into touch with the most appropriate authoritative sources.

Since the Ministry has so promptly taken up this case of co-operation, we would draw their attention to another urgent problem requiring solution. It happens on occasion that, following upon a "priority call" for some castings, the patternshop works through the week-end; the moulders and coremakers are taken from the normal jobs and work continuously until the castings are made. The staff stay late at night to help with the despatch of the first casting made. The rest of the batch are fettled up and await further instructions. Weeks pass and still the ultra-urgent castings "clutter up" the despatch department. We have had sufficient participation in large-scale operations to be able to envisage a dozen really acceptable excuses for such events—initial failure, different material required, non-delivery of another component or testing apparatus, a change in tactics, and so forth. Yet, no matter what happens, it is psychologically a silly mistake by the Ministries to ask foundries temporarily to disorganise their production programme, to create a maximum of enthusiasm amongst a large number of already enthusiastic workpeople, and then to leave in their midst—what is generally accepted to be—monuments to the ineptitude of the officials concerned. It is told of the last generation of apprentice moulders that it was customary, when having made a waster casting, to bury it in the sand, and the area so used was known as the cemetery. Whilst economically this was reprehensible, psychologically it was good. We do not suggest that the Ministries create a "Memorial Park," but we do ask them to maintain interest in their ultra-urgent experiments, even if this involves their being present at the obsequies.

It is to be regretted that the foundry industry cannot present to the designers attached to the various Ministries an authoritative textbook on the design of castings. So, in lieu of this, we suggest that, wherever possible, foundrymen make propaganda for co-operation, whilst "castings" are on the drawing board. Every year, month and week, the foundry loses perfectly good orders to competing industries because of this lack of initial co-ordination of effort. We shall not rest until every draughtsman has at his elbow as a companion work to "standardised steel sections" a castings handbook of an authoritative character. Until this desirable consummation is effected, reliance must be placed on individual propaganda. Where co-operation does exist, it is being increasingly noticed that the designers become not merely "castings conscious," but enthusiastic for cast products.

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Institute of Vitreous Enamellers

ANNUAL GENERAL MEETING AT BIRMINGHAM

The annual general meeting of the Institute of Vitreous Enamellers was held at the Grand Hotel, Birmingham, on Saturday afternoon last. Prior to the business proceedings there was a luncheon, and before the members finally separated Mr. S. G. Tinsley, B.A., B.Sc. (British Titan Products Company, Limited, Billingham) read a Paper on "The Applications of Titanium Oxide in Vitreous Enamels," the first part of which appears elsewhere in this issue. This was followed by a discussion. The reading of a Paper prepared by Dr. G. T. O. Martin (British Cast Iron Research Association), dealing with the "Properties of Enamel Opacifiers," was deferred, and members having been supplied with copies of the Paper they were invited to send in written criticisms and questions.

In the absence of the President (Prof. J. H. Andrew), the Chairman of the Council (Mr. W. H. Whittle) was in the chair. In all there were 26 apologies from members unable to be present.

Chairman's Review

Reviewing the year's work, the chairman said the second wartime annual meeting saw the Institute still firmly established and ready for the part it would have to play in the post-war reconstruction. The Institute's financial position had been consolidated, and the membership well maintained. It had been necessary to regard a number of persons and firms as no longer members due to notice of resignation, loss of contact, or non-payment of subscriptions, but it was to be hoped that many of these would join the Institute again in better times. In many letters of apology for absence, good wishes and hopes for the future of the Institute were expressed. There had been little activity in the various Sections during the year, as it had been difficult to arrange lectures and works visits, but the Southern Section, at least, had plans for the present winter season. The Council had met seven times during the year and made decisions on a number of subjects of importance to members. Co-operation with official bodies and departments, such as the Ministry of Supply, the British Standards Institution and the British Colour Council, had been continued. The programme of research was being continued under the supervision of a specially formed research panel, which also dealt with technical inquiries received. The second report on Chemical Resistance of Enamels had been published, while two reports dealing with the adherence of enamel to sheet iron were at present being discussed prior to publication. Work on enamel opacifiers was also in progress. A survey of the literature, and of industrial practice, relating to the whole subject of enamel opacity would shortly be available as a special publication. The sixth annual proceedings and quarterly copies of "Enamelling Abstracts" had been circulated as in previous years.

"You will, I feel, appreciate," the chairman added, "the difficult period through which this and similar institutes are passing. Your Council have given careful consideration to the future development of the Institute, and the conclusion arrived at is that we should continue the work that has so successfully been started. On account of the number of enamelling plants that have either been closed, or the operations considerably reduced, I feel it is of the utmost importance that technical work should be carried on as far as possible, as it will be difficult, in any case, for the trade in general to get going after the war."

(*Concluded in next column.*)

Institute of British Foundrymen

New Members

New Members.—In the list of new members elected to the various grades of membership of the Institute of British Foundrymen, at Leeds, on October 18, Mr. D. Anderson, company secretary, was incorrectly stated to have been elected an Associate Member. He was elected a Full Member.

Notes from the Branches

Burnley Section.—The second meeting of the session was held on Tuesday last, in the Burnley Municipal College, Ormerod Road, when Mr. Pell, Burnley, presented a Paper entitled "An Interesting Foundry Problem."

Mr. S. Brooks, of the Stanton Iron Works Company, Limited, was the lecturer at the October meeting of this Section of the Lancashire Branch. The meeting was held in the Accrington Technical School and was attended by about 40 members. The lecturer made good use of a cinema film to illustrate his talk, which covered the history and manufacture of pig-iron. After reviewing the antiquity of the foundry industry, Mr. Brooks dealt with the history and development of the blast furnace, detailing the construction of a modern plant, and the influences of working conditions upon the composition of the product. In conclusion, he differentiated between the properties of sand- and machine-cast pig-iron. The lecturer was cordially thanked for providing the members with a thoroughly acceptable review of the production of their most important raw material.

Catalogues Received

Lighting. Siemens Electric Lamps & Supplies, Limited, 38-39, Upper Thames Street, London, E.C.4, have sent us a revised price list, No. 976, which supersedes No. F.T. 966, covering in a four-page leaflet the field of fluorescent tubes and their fittings.

A.R.P. Shelter Heating. Two leaflets received from the Eagle Range & Grate Company, Limited, 7, Stratford Place, London, W.1, illustrate and describe a range of coal and coke fired stoves. The one devoted to the coal-fired model details two sizes, whilst the second one—the coke-fired series—lists five. In both cases provision is made for using an air supply external to the actual shelter where gas-proof conditions have to operate. Whilst these new designs are essentially utilitarian, the reviewer feels sure that their economic functioning will find a permanent place in the future for the heating of rooms of a non-domestic character.

(*Continued from previous column.*)

The hon. treasurer (Mr. W. S. Grainger) was unable to be present, and on his behalf the annual accounts were submitted by Mr. R. J. Sharratt. The income, he said, was £562, compared with £534 last year, and there was a surplus on the year's operations of £2 13s. 6d. The chairman having made the comment that the financial position was better than appeared, the accounts were accepted.

Prof. Andrew was re-elected President, and the following were elected to the Council: Messrs. W. H. Whittle, J. Nicholls and C. P. Stone. Messrs. Wenham Bros. were reappointed auditors.

The technical meeting followed, with Mr. W. Todd in the chair.

Random Shots

It is not long since a much overworked foundryman complained bitterly that he could never find time to go and have his hair cut. The remedy he suggested was to insert an advertisement in the Journal: "Wanted—hairdresser; only those with good knowledge of metallurgy need apply." The idea is not so mad as it sounds, however, for "Marksman" has recently heard of a barber, bombed out of his London shop, taking up work as a moulder in the provinces. What is more, he manages to earn an honest penny at "barbering" in the lunch hour. It must be added, however, that he does his foundry work in gloves.

* * *

Apropos of barbers, a schoolboy wants to know if waiting to have your hair cut is called "barbecueing"?

* * *

The introduction of further rationing has caused a new flood of conversation about food and feeding, and indeed when one remembers the grocery lists which were made out without even a thought at about this time of the year in pre-war days, the marvel is that the country is managing so well, rather than the reverse. The items on those lists were about 90 per cent. foreign products and one is apt to forget, now that feeding has become so much simpler, how much the English table depended on Continental produce for its variety and interest. A typical pre-Christmas grocery list almost certainly would include boxes of Carlsbad plums (so familiar in their little stencilled boxes); Chinese ginger or Chowchow, in their fascinating earthenware jars; whilst Italian gorgonzola would serve until the English Stilton should be sufficiently ripened. The discerning palate would demand that Strasbourg *pâté de fois gras* be "got in," and that the crystallised fruits should come from Metz. The epicure would call for caviare from Russia as a contrast to the ordinary mortal who would put up with bloater paste.

* * *

If your grocer was of the sort and size to possess a wine department, that pre-Christmas order would certainly have an appendix. It is worthy of note, however, that two of the most popular items on this list would have been of British origin, for whisky and gin would run close favourites with French brandy, Spanish sherry, and Portuguese port.

* * *

Ah, well! These times will come again. In the meantime there is still a modicum of English beer and lots of Iceland cod.

* * *

Incidentally, a man charged in court the other day with being found in the road hopelessly drunk and incapable, pleaded that he had fallen on a banana skin. In these days one is almost as impossible as the other, but it turned out afterwards that he wasn't drunk, after all. He had been walking home just slightly gay when he saw the local A.F.S. engines standing in the road. His eye caught the contraption at the side labelled "foam" and he had been unable to resist drawing himself another pint.

* * *

Not to be Beaten!

A firm of coastal coaches services, now that they can no longer offer pleasant day trips to Little Mudcombe-on-Sea, are weekly displaying the following notice:—

"Book here for Dashwood Mental Hospital. Start 2.30 p.m. Return fare 5s."

(The pleasantest feature of the trip, by the way, is that no quotation is given for single fares!)

"MARKSMAN."

Fuels and Furnaces for the Heat Treatment of Steel Castings*

By T. R. WALKER, M.A., F.I.C.† and F. SMITH, Assoc. F.‡

The selection of the type of furnace to carry out a definite duty in a specified place is governed primarily by the nature of the available fuel. If a furnace is properly designed to utilise a particular fuel and is skilfully operated, it will give satisfactory results. With the same qualification, many types of fuels and furnaces can be used successfully. Since heat-treatment is, however, usually only one process in the production of steel articles such as castings and, in addition, is often considered an operation of minor importance, there is a common tendency to pay little attention to the furnaces or their working, so long as delays in output or rejections for inadequate properties do not occur too frequently. This applies more particularly to large furnace installations, fired by producer gas, where it is usually very difficult to arrive at a reliable figure for the operational cost.

Heat energy for industrial furnaces is obtained by the combustion of fuel, or by the conversion of electric energy which, in this country, is generated by the combustion of fuel. The fuels available in quantity may be classified as follow:—

Gaseous—(*a*) Rich gases such as town's gas, coke-oven gas, carburetted water-gas, blue water-gas; (*b*) lean gases such as raw producer gas, clean producer gas, coke producer gas, blast-furnace gas.

Liquids—Light fuel oils, heavy fuel oils, tar oils, tar, pitch.

Solids—Coal or coke on the grate, pulverised coal.

Of the three types, gaseous fuels have advantages over the other two, since they are easily carried to the furnaces. They can be properly mixed with air without previous preparation, and mostly burn without smoke even in a cold furnace. The control of temperature and furnace atmosphere is easiest with gaseous fuels.

Town's Gas and Coke-Oven Gas

These are very similar in analysis and properties, especially as many gasworks nowadays mix large proportions of coke-oven gas with their coal gas. They are produced by the high temperature distillation of bituminous coal and have a gross calorific value of 500/550 B.Th.U. per cub. ft. Owing to the richness of the gas, pipe lines can be small and high flame temperatures can be obtained. The composition and calorific value are almost constant, so that accurate control of temperature and furnace atmosphere is possible. The installation of a furnace to burn these gases requires little additional equipment and is not expensive, whilst the cost of labour attendance and maintenance is low. These fuels are very useful for small and medium size furnace installations, and also wherever furnaces are to be used intermittently, since there is practically no standby expense. The high cost of the fuel is a disadvantage, the importance of which varies in different localities owing to the varying price of the gas.

These gases can, of course, be used only in the neighbourhood of gasworks and coke ovens, whilst the danger of interruptions to the gas supply is undoubtedly a disadvantage in wartime. In some works it has been necessary, owing to the inadequacy of purifying plant at the gasworks, to use crude coke-oven gas. This is liable to give solid deposits in the pipes near the furnace, and especially in the burners, leading to an increased maintenance cost and greater difficulty in maintaining close control of temperature. It also contains a comparatively large amount of sulphur which can be absorbed in the surface layers of articles in the furnace. This type of gas is therefore not suitable for heat-treatment, especially for thin articles the surface area of which is considerable compared with their weight.

Water-Gas

This is produced when steam is blown through coke at a white heat. The reaction cools the coke, which is reheated by a current of air blown through it and allowed to escape. The production of water-gas is thus intermittent unless two generators are used, one making gas while the coke in the other is being reheated. The gas consists of equal volumes of carbon monoxide and hydrogen, with small percentages of impurities such as carbon dioxide and oxygen. In this state it is known as blue water-gas, and has a calorific value of about 300 B.Th.U. per cub. ft. It can also be enriched by the addition of gaseous hydrocarbons derived from the rapid heating of oil to a high temperature. It is then known as carburetted water-gas and has a calorific value of 500 to 500 B.Th.U. per cub. ft. If the gas be so enriched, additional equipment is required to remove suspended tarry matter, and the process of gas-making becomes more complicated.

Compared with other industrially produced gases, water-gas has a high calorific value, giving high flame-temperatures and allowing accurate control of both furnace atmosphere and temperature. It can be burned efficiently and is a clean fuel. On the other hand, the cost of installation of the plant is high and the cycle of manufacture not simple. Facilities must be provided for handling coke and ashes, and the labour cost is high. Thus, the cost of production of the gas becomes a serious one, especially in small installations. It can be cheapened, more particularly in large installations, by the provision of waste-heat boilers, to make steam from the heat otherwise wasted during the heating up of the coke by the air-blast. These boilers increase the capital cost, but decrease the subsequent production cost of the gas. Unless the load on the generators is practically constant, some form of gas holder must be provided to deal with the varying load on the generators. This is an additional item of capital expenditure, but does not appreciably affect production costs subsequently.

Raw Producer Gas

This is made by passing a mixture of air and steam through a layer of red-hot carbon, usually in the form of bituminous coal, though coke, anthracite, wood and other carbonaceous substances can be used if the plant be suitably modified. If the producer be near the furnace, the gas reaching the furnaces is still hot and also contains finely divided tar suspended in it, both of which increase the heating value of the gas. The calorific value of the gas varies considerably according to conditions, but a typical range is from 150 to 170 B.Th.U. per cub. ft., which is low compared with the gases previously considered. On this account, and also because it contains suspended dust particles from the coal as well as particles of tarry hydrocarbons, it must be conducted through flues of large diameter, usually brick-lined, and burned at large ports. As the calorific value of the gas is low, furnaces burning producer gas usually include some arrangement for heating the air required for combustion. This preheating of the air, and frequently of the gas also, is carried out by means of regenerators, normally placed underneath the furnace. These increase the efficiency of the furnace but at the same time increase its capital cost.

As the flow of air and gas through the regenerators is periodically reversed, the air ports at either end of the furnace are of the same size, and the same applies to the gas ports. Since the gases leaving the furnace are much hotter than those entering the furnace they occupy a larger volume, and therefore the velocity of the exit gases is greater than that of the entering gases, so that the entering gases mix comparatively slowly and give a long lazy flame over the charge.

The advantages of producer gas are considerable. The installation cost is lower than that of other industrial gas-making equipment, the operating cost per B.Th.U. is low, and gas making is a reasonably simple process. The plant can be used wherever bituminous coal (or in special circumstances other carbonaceous materials) is available. The disadvantages include the provision of facilities for handling coal and ashes, and the necessity for a steam supply. To obtain the best results, the size of coal must be between fairly definite limits, and the coal must not swell too much on heating. Large gas mains must be used, and these must be cleaned periodically on account of deposits accumulating in them.

Clean Producer Gas

This is prepared by cooling and scrubbing the raw producer gas, a process which removes dust and suspended tarry matter. The cleaned gas will not cause deposits in flues, and makes it possible to use burners instead of ports. The cleaning plant required occupies a substantial amount of room, and demands an adequate supply of water for cooling and washing. The tar, deposited in the form of a viscous liquid, is a commodity for which there is little demand, but it must be regularly disposed of. As the sensible heat of the gas and the combustible tar are both removed, the heating value of the gas is diminished. Since producer gas cools steadily as it passes through mains and gradually deposits tar at the same time, the heating value of raw producer gas decreases progressively as the distance between the producer plant and the furnaces is increased. Thus, the loss in heating value in changing over from raw to clean producer gas in a given plant depends on the relative positions of producers and furnaces.

If a new plant be under consideration, then the capital cost of the furnaces can often be reduced if clean producer gas is used, since comparatively small recuperators, which would soon become stopped up if raw producer gas were used, are often adequate. This helps to pay for the capital cost of the cleaning plant. Clean producer gas permits closer control of furnace atmosphere and temperature, and automatic temperature control can be utilised. This gives a saving in fuel if the plant is carefully operated, and so contributes towards the cost of cleaning the gas.

It is clear that the cost of cleaned producer gas per B.Th.U. is greater than that of raw producer gas, but the actual difference depends on the circumstances of each case. Some advantages of clean producer gas are often difficult to assess monetarily. For example, clean producer gas with a calorific value of, say, 150 B.Th.U. per cub. ft. and town's gas with a calorific value of 500 B.Th.U. per cub. ft., can be mixed in proportions to give a mixed clean gas of any intermediate calorific value, such as 300 B.Th.U. per cub. ft., which is equal to that of blue-water gas. Thus, if there is a shortage of town's gas the supply can be eked out and production maintained, even in a batch

* Paper read before the Lancashire Branch of the Institute of British Foundrymen, at a meeting on November 1.

† Fuel Officer, English Steel Corporation Ltd.
‡ Fuel Laboratory, English Steel Corporation Ltd.

Heat Treatment of Steel Castings

of small furnaces with burners of narrow section, without the burners becoming stopped up. If such furnaces, normally operated continuously by clean producer gas, are required for any reason to work intermittently they can be operated, with little alteration in the control settings, by town's gas as an alternative fuel. Similarly, if only one or two such furnaces out of a row are required, they can be put on town's gas without the necessity of operating the gas-producer plant.

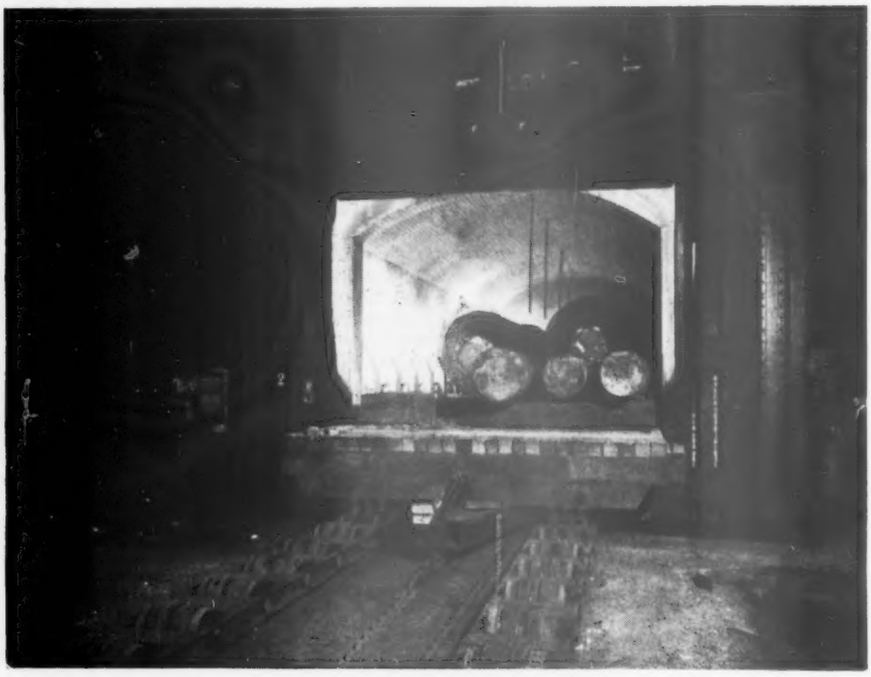

FIG. 1.—LARGE PRODUCER-GAS FIRED FURNACE WITH HEAVY BOGIE.

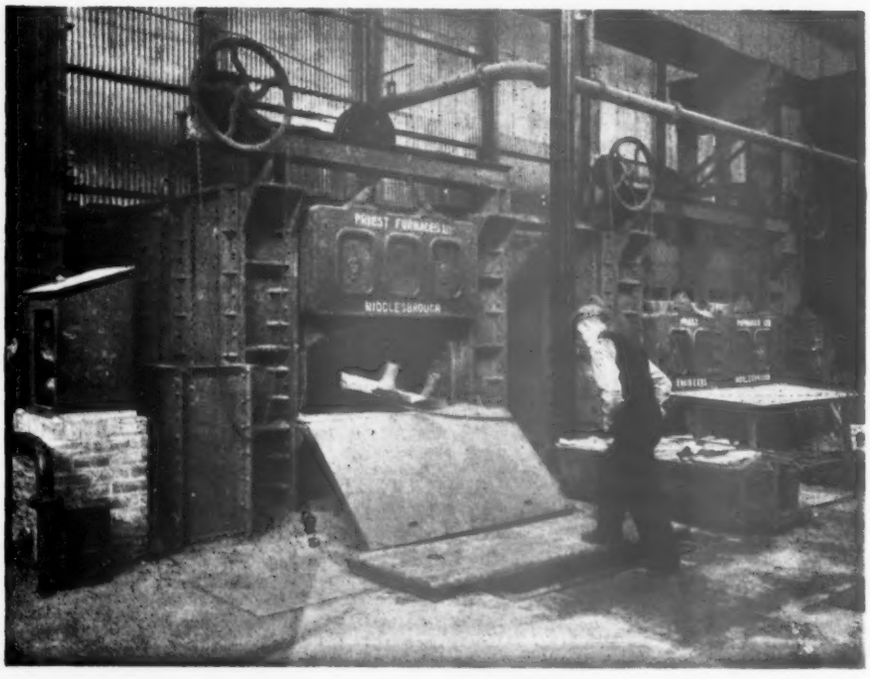

FIG. 2.—SMALL TOWN'S GAS FIRED FURNACES WITH APRON AND TANK.

Coke-Producer Gas

Producer gas can be made by blowing air mixed with steam through red-hot coke instead of coal. The gas resembles raw-coal producer gas except that it contains no suspended tarry compounds, and therefore has a somewhat lower calorific value. When the dust which it contains has been removed, the gas has an almost non-luminous flame and can be ignited at burners like clean coal-producer gas and town's gas. To obtain the best economic results, the furnaces should be fitted with recuperators or regenerators, on account of the low calorific value of the gas.

Coke-producer gas can be conveniently mixed with town's gas to give a fuel with an intermediate calorific value which can be used regularly so long as town's gas is available, and in these circumstances the producer plant can be worked at less than its maximum capacity. If the supply of town's gas be cut off or decreased, gasification at the producer plant can be increased, and the furnace output maintained more or less at its usual figure.

Blast-Furnace Gas

This gas, which is given off during the operation of blast furnaces, is the leanest of industrial gases, having a calorific value of only about 90 B.Th.U. per cub. ft., and is available only in or near works having blast furnaces. It is a by-product fuel and is therefore cheap. Owing to its low calorific value, it must be carried in large mains, and its pressure must often be increased by a booster to obtain sufficient heat in the furnaces. Efficient preheating of the air, and usually of the gas, too, is necessary to obtain high furnace temperatures. Blast-furnace gas is also used for mixing with coke-oven gas to give a mixed gas which can still have a calorific value ample for industrial purposes.

Liquid Fuels

In this country liquid fuels are used much less extensively than gaseous fuels, especially for heat-treatment furnaces. The liquids consist essentially of mixed hydrocarbons derived from two sources:—

(*a*) As products of the fractional distillation of naturally-occurring oils, practically all of which are imported into this country.

(*b*) As mixtures obtained by the treatment of domestic tar liquors, produced in the manufacture of town's or coke-oven gas.

At the present time the number of available liquids is limited, and whilst the supply of some fuels of domestic origin is adequate, that of imported fuels is severely restricted.

The light liquid fuel available at the present time comprises the Pool Board grades known as Pool Fuel Oil and Diesel oil. This Diesel oil is an imported oil, with a calorific value of approximately 19,000 B.Th.U. per lb. and a specific gravity of 0.895, equivalent to 170,000 B.Th.U. per gall. It is, however, required almost entirely for road transport and similar purposes, and little is available as an industrial heating fuel. Creosote B is a Pool grade of heavier oil of domestic origin, with a calorific value of 16,000 B.Th.U. per lb. and a specific gravity of about 1.07, equivalent to 170,000 B.Th.U. per gall. Ample supplies are at present available for industrial heating. Creosote A is a lighter and less viscous fuel, but supplies are by no means plentiful, and continuance of supply cannot be guaranteed. Creosote B/Pitch is a mixture of Creosote B with some of the pitch residue from the distillation of coal, and is more viscous than Creosote B. If supplies of Creosote B became unequal to the demand, the supply of liquid fuel could quickly be increased by extending the use of the Creosote B/Pitch mixture. It is therefore highly advisable, in an oil-burning plant, to cater for the use of both Creosote B and Creosote B/Pitch mixtures.

In order to facilitate handling, these two fuels are loaded hot into a road wagon, and, when received at the consumer's works, are still hot enough to flow satisfactorily. The liquid is usually discharged into storage tanks, from which it is distributed to the furnaces, through a pipe line, or in portable tanks to small overhead tanks serving one or two furnaces. To enable them to flow through pipes, these fuels must be kept at a temperature of from 90 to 100 deg. F., and should be further preheated to about 200 deg. F. at the burners. This heating of the fuel in tanks may be carried out either by steam coils or by electric immersion heaters.

Heat Treatment of Steel Castings

whilst the pipes through which the oil flows may be lagged with asbestos rope to minimise the cooling of the oil. Creosote fuels are apt to contain acids, which attack brass and other non-ferrous fittings, and this point must not be overlooked when imported fuel oil is being replaced by creosote fuels.

As a class, liquid fuels possess most of the advantages of the richer gaseous fuels, since the capital cost of furnaces and auxiliaries is low and little other equipment is necessary. High flame and furnace temperatures can easily be obtained, and the fuel, which has a high calorific value, can readily be transported. An additional advantage is that liquid fuel can easily be stored in a comparatively small space. There are no standby losses, which cannot easily be avoided when producer gas or water gas is used. The cost per B.Th.U. with liquid fuels is higher than for gaseous fuels, the fire hazard is increased, and the very high flame temperatures easily reached are liable to damage the furnace structure, and also the steel charge, unless proper care is exercised. If a reducing atmosphere is required in the furnaces, the use of preheated air is necessary, to avoid the production of an excessive amount of smoke. Liquid fuels are used more for reheating stock for forging or drop stamping than for heat-treatment, chiefly because the operation and control of oil-fired furnaces becomes more difficult as the furnace temperature is reduced, especially when heavy oils must be used.

Solid Fuels

Coal itself is the most important industrial fuel, since all the fuels described above, except those derived from petroleum oils, are obtained either directly or indirectly from coal. The term coal covers a wide range of carbonaceous materials differing considerably in almost every respect, their properties, however, having a decisive effect in determining the suitability of a given class of coal for a specific purpose. As a fuel, coal is still the cheapest in prime cost, and where furnacemen are trained to use it properly, it can give excellent service in a variety of furnace installations. Frequently, however, the duties of a furnaceman include many activities other than firing, with the result that firing is done very heavily at infrequent intervals, leading to continual variations in the furnace atmosphere and temperature.

The advantages of coal as a direct fuel are that the costs of fuel, furnace installation and operation are low, whilst storage of the fuel is easy if space and surplus fuel are both available. In wartime it is not, however, always possible to obtain adequate quantities of coal with the properties and size distribution desired, nor is it easy to obtain and retain skilled furnacemen. The necessity to provide facilities for handling coal and ashes is a disadvantage. Unless the furnaces are well designed and operated skilfully, considerable variations occur in furnace temperature and atmosphere, excessive oxidation of the charge results, and there is an increase in the maintenance cost of fireboxes and grates.

One application for which coal is particularly suitable is in the operation of small plants where producer-gas or water-gas installations would be too expensive. Small isolated furnaces can be heated efficiently by an automatic underfeed stoker, of which a number of good types are now available. If suitable fuel be used, these stokers require little attention and give very good control of the furnace temperature.

Coke.—The advantages and disadvantages of coke as a fuel are similar to those of coal. It is, however, more expensive and supplies are sometimes more difficult to ensure. During wartime there is an increased tendency for supplies to vary in successive consignments, owing to changes in the quality and source of the coal supplied to the coke ovens. It cannot produce a smoky black atmosphere, but on the other hand to secure a neutral or reducing atmosphere demands very heavy firing.

Pulverised Fuel.—The heating of furnaces by pulverised fuel is by no means uncommon, but it is used for reheating stock for forging and similar operations rather than for heat-treatment, since it is more suitable for obtaining high furnace temperatures than the medium or comparatively low temperatures used in heat-treatment. The pulverised fuel is usually obtained by crushing coal of singles size, and unless comparatively expensive drying equipment is installed it is difficult to ensure a regular supply of dry powdered coal at the burners, especially during wet weather. This

(*Continued on page* 306.)

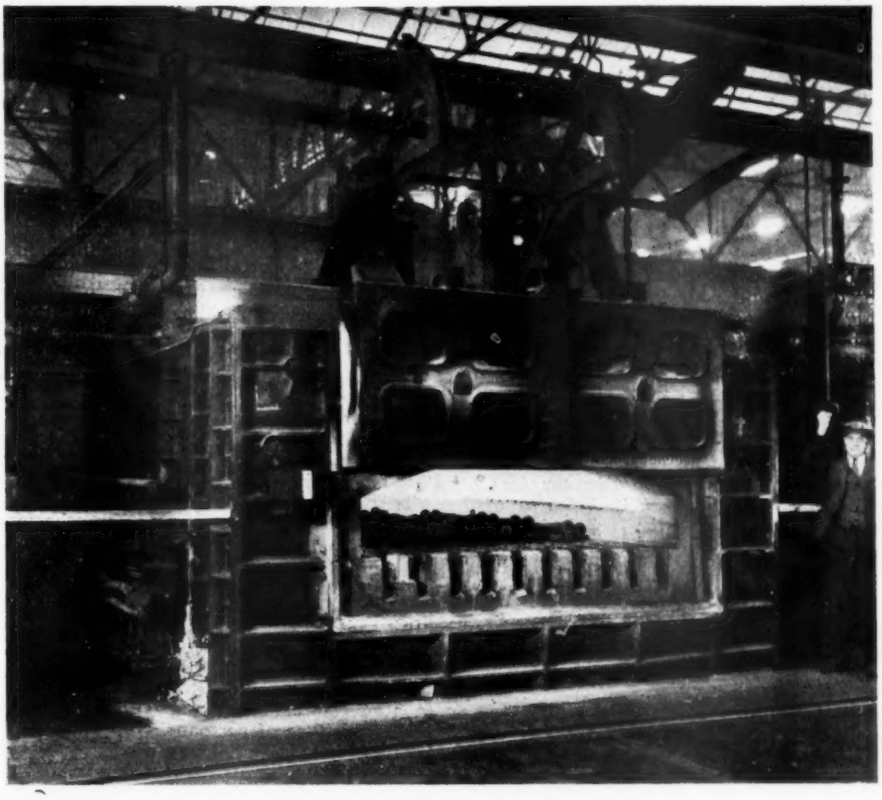

FIG. 3.—TOWN'S GAS FIRED FURNACE WITH PIER HEARTH.

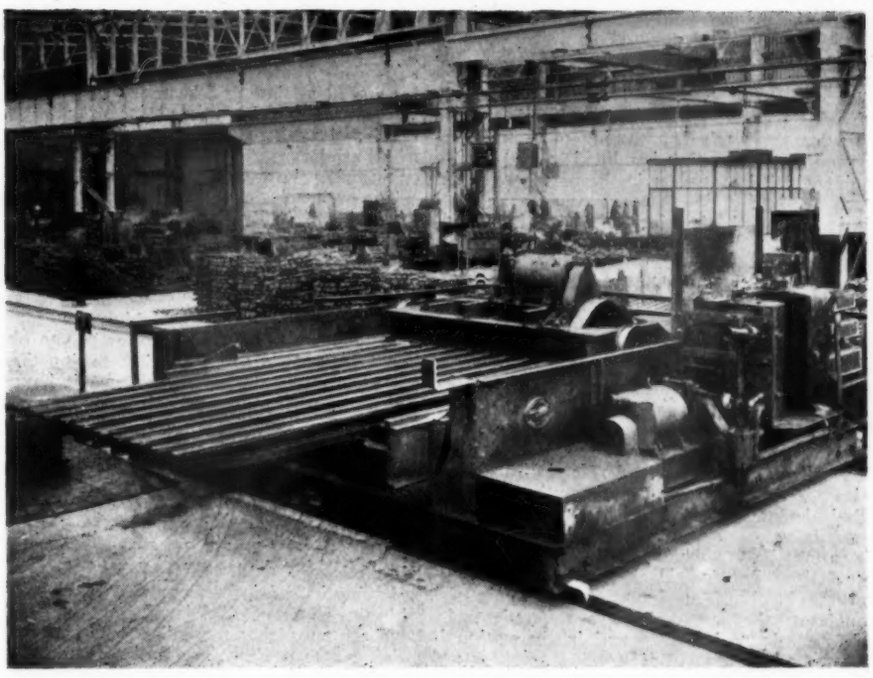

FIG. 4.—ELECTRIC CHARGING MACHINE ON WIDE GAUGE TRACK.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Co-operation

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The letter on the subject of "Co-operation," signed "A.M.I.B.F.," which appeared in your issue of October 16, has naturally received a great deal of attention, but surely it is the foundrymen themselves who are largely to blame for the state of affairs described by your correspondent. Is not the root of the trouble that foundrymen will not avail themselves of the facilities and services so freely offered by the various technical and advisory bodies which have been set up and which are only too anxious to be of assistance to them and to the national effort? A great deal of mutual co-operation can be and, in fact, actually is already being effected through the medium of such bodies, and unquestionably really useful service has already been given to those who have turned to these authorities for the solution of their problems or for powers to co-operate with others faced with similar difficulties.

Some 18 months ago the Director for Iron Castings under the Iron and Steel Control of the Ministry of Supply set up a Technical Advisory Panel with the special object of assisting the foundry industry in all its wartime problems. This Panel is composed of nationally recognised authorities on the iron foundry industry, including representatives of the Technical Committee of the Institute of British Foundrymen, of the British Cast Iron Research Association and other bodies. The activities of the Technical Advisory Panel should be well known to all connected with the foundry industry, and at least three times the industry has been circularised inviting them to co-operate with the Panel. As a result a large number of industrial problems have already been considered, and it has been possible in special cases even to agree on standardised production methods, which have been acceptable to a number of firms engaged on the manufacture of the same article. It would appear that the particular trouble experienced by "A.M.I.B.F." is one in connection with which the Panel could be of assistance if they were approached, assuming of course that the problem in question is related to cast iron—a point which is not clear in the correspondent's letter.

It is suggested, therefore, that "A.M.I.B.F." and any of your other readers who may be in trouble should make more use of the Technical Advisory Panel. They should in the first place write to the Joint Directors for Iron Castings at the Clarendon Hotel, Leamington Spa, who would refer the matter to the Advisory Panel if coming within their scope, or who could refer the problem to other authoritative bodies so as to obtain the most satisfactory and rapid solution.

Incidentally, one wonders whether "A.M.I.B.F." has considered referring his difficulties to his own technical authority, the Technical Committee of the Institute of British Foundrymen.

It cannot be too widely known that not only for cast iron but for all classes of non-ferrous alloys and other products technical experts throughout the country have offered their services freely to industry, and in the national effort. These Panels of experts are only too anxious that industry should come to them and make the fullest possible use of the assistance they are in a special position to give.

Yours, etc.,

A. B. EVEREST

(Secretary of the Technical Advisory Panel to the Director for Iron Castings, Ministry of Supply).

Grosvenor House, W.1.

October 28, 1941.

Foundry Education

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—The writer was particularly interested in the "leader" "Planned Foundry Education," published in the October 23 issue of THE FOUNDRY TRADE JOURNAL, and also in the American Paper "A University Course in Foundry Control Methods," because these two articles show very clearly that the foundry trade throughout the world has at last realised that it must plan for the future on a long-term policy, in order to bring forward the right type of properly-trained foundry executives. The Sheffield University Course and the Foundry School in Birmingham are excellent examples of what can be done to bring thoroughly-qualified foundrymen and metallurgists into the industry.

It should not be thought, however, that Great Britain was the only country which may have been backward in providing a thorough foundry technical education, for I think it can safely be said that the U.S.A. has only within the last few years realised that something had to be done in the way of thorough training in order to bring forward the right type of personnel to fill foundry control and executive positions, and the Paper by Holtby and Scobie corroborates this, in addition to indicating one scheme whereby the problem can be partially solved. There are, of course, many other schemes in the States, such as similar University courses and apprenticeship training courses run by many of the large firms. The training of these apprentices seems to me to strike the right note, because it gives a chance for the man or youth "on the floor" to improve his knowledge to that of a fully trained foundry engineer, and I believe that we should endeavour to carry out to a greater extent than at present the training of this type of personnel.

We all know the difficulty of persuading boys to enter a foundry, or if they do take such employment, of persuading them to take their trade beyond that of just earning a weekly wage, but I am not so sure that much of this difficulty is not due to the fact that what one might call the better type of boy is apt to regard the foundry as being without the possibility of attaining the advancement such as is offered in the engineering industry, though I hasten to query whether this could be substantiated in fact, bearing in mind the number of boys and youths that enter what might be termed "blind-alley jobs" in engineering shops.

The writer believes it is agreed that perhaps the major difficulty has been that such boys and youths have not altogether been encouraged in the way they should have been, had foundry employers had sufficient foresight to realise that they would see a time when fully-trained foundrymen, capable of taking on foreman positions, would be almost impossible to obtain, and by this I do not mean just during the war period. In the writer's experience it happened many times before the war that posts were open for fully-qualified foundrymen which could not be filled.

Members of the Institute of British Foundrymen know that the Institute has given a great deal of time, thought and money to the furthering of foundry education by supporting to the full the Sheffield University Scheme and also the Birmingham Foundry High School, in addition to having its Advisory Committee, which jointly with the City and Guilds of London Institute, have set up such an excellent syllabus for the training of patternmakers and also for general foundry practice.

Like the writer of your "leader," I believe that the course on foundry control methods is an excellent way of quickly and partially supplying the deficiencies of foundry executives, but we must not advance too rapidly, for in this country we have still to bear in mind the fundamental factor; and Mr. J. G. Pearce realised this when, as your "leader" says, "he launched the Foundry High School Scheme, and his object was to give theoretical training to the practical, and practical tuition to the academic." In this direction the writer felt sure you would be interested in learning what we are endeavouring to do in this part of the country to further foundry education.

A short time ago the Principal—Mr. T. S. Harker—of the Ipswich School of Engineering approached the writer and asked if he thought that the local branch of the I.B.F. would be prepared to set up an Advisory Committee to the School on foundry technical education. The committee was duly formed and the writer has the honour of being chairman, and whilst we do not want to say too much about our programme in these early stages, you will no doubt be interested to learn that we have on the committee representatives from all the engineering firms in the Ipswich district who operate a foundry. We have with the approval of the Board of Governors of the School set up a provisional programme which aims at the provision of a foundry practice and science course and a patternmaking course based on the City and Guilds syllabus. There will, of course, be the normal class instructors, but also it is proposed that talks will be given to the students in specialised subjects such as sand testing and control, cupola practice and such like by visiting lecturers, and so far we have received quite a number of offers to give these talks. This idea, which incidentally was borrowed from the practice adopted by the Foundry High School, was regarded by our Advisory Committee as being an excellent means of maintaining the interest of the students.

In the first place it is, of course, proposed that the courses shall be elementary, stepping up each year until, if we have sufficient students available, we may have three individual courses running in each subject, and after reading the Paper on "Foundry Control Methods" I think it is very possible that we will introduce in the future such a foundry control course into our programme.

I would like to say that we have been given excellent support by the local education body in this matter and Mr. Harker is particularly keen; in fact, we owe the suggestion of a foundry training course to him. So far the number of students available seems very promising, and while we do not at this exceedingly early stage want to "count our chickens," we are sincerely hoping that this experiment will lay a solid foundation in this part of the country for the production of sound foundry technical training and of some few foundry executives-to-be who really will be executives in every sense of the word.

In conclusion I believe our friend, Mr. C. H. Kain, could give a very interesting account of what he and his colleagues are doing in their district to foster foundry technical education, but there I must leave it.—Yours, etc.,

Crane, Limited,

H. H. SHEPHERD.

Ipswich.

October 27, 1941.

Fire-Fighting Trains

Special fire-fighting engines and trains are stationed at key points on the railways ready to go wherever they are needed. One of these trains has six locomotive tenders holding 15,000 galls. of water. It has several 20-h.p. petrol motor pumps, which deliver water at a pressure of 60 lbs. per sq. in. This means that fires on the roofs of buildings several storeys high can be successfully fought. The amount of water carried will enable the pumps to operate for some 2½ hrs. Another type of fire train has a coach for the accommodation of a crew of eight firemen and a covered carriage truck specially adapted for carrying two light trailer pumps with full accessories, such as hose, stirrup pumps, sand and water buckets, fire extinguishers, etc. The trailer pumps have a delivery of 150 galls. per min. and are similar to those used by the A.F.S.

Non-ferrous Steam Valve Lids

A PRACTICAL DISCUSSION AT OPENING MEETING OF EAST MIDLANDS BRANCH OF INSTITUTE OF BRITISH FOUNDRYMEN

Mr. Frank Hudson re-presented his Annual Conference Paper, "Moulding Steam Valve Lids for Marine Service"* at the opening meeting of the East Midlands Branch, over which Mr. H. J. Beck presided and opened the discussion.

MR. BECK asked what was the ratio of feeder head to castings, and suggested that Mr. Hudson went further into the proposed method of feeding and altered the shape of the feeder head from a straight taper to a parallel cylinder with a spherical base, ¼ in. larger in diameter than the boss on the castings with a feeder saddle on the pattern equal in size to the pattern boss, standing $\frac{3}{16}$ in. high and slightly tapered towards the feeder head to define the cutting off line. This type of feeder head would ensure that the metal was kept liquid longer than the tapered type, and therefore the feeder head could be appreciably reduced in height.

MR. HUDSON said that the weight of feeder heads in the majority of cases was fully equal to the weight of the castings. Foundrymen producing these castings might be able to decrease the size of heads, but personally he was not prepared to say that these should be reduced as a general principle. He agreed with Mr. Beck's remarks in connection with the modified form of feeding head and considered there was a great deal to be said for a sudden thickening of the head as it left the casting, as illustrated in Fig. 4 of the Paper, in comparison with the straight taper type shown in Figs. 1 to 3. He did not altogether agree, however, that a parallel cylindrical feeder was an advantage even if this was of a much greater diameter than the casting section. There was much to be said for tapering the riser above the shouldered portion to assist progressive solidification.

Progressive Solidification

MR. A. E. PEACE thought that it must be due to wartime censorship that Mr. Hudson had been unable to give the composition of the alloys that he was dealing with, but it was clear that these were high-nickel alloys, and he felt that many people who were not experienced in non-ferrous work would have been astonished at the extent to which the elimination of cores and the adding of metal to effect a progressive solidification had been taken, but it should be borne in mind that these metals were expensive, and the ratio of the metal cost to the productive labour cost was entirely different from that of cast iron, and the machining to remove the added metal was simple and consisted largely of drilling.

Another aspect was the matter of high temperature casting. He felt that in speaking of the shrinkage of metals it was necessary to understand the metal under consideration, and as he was not familiar with these alloys, he wondered if Mr. Hudson could briefly and in a simple way enlarge upon the consideration of these metals from the phase aspect because all these were of course of paramount importance in the shrinkage of the metal. There were two aspects of this temperature of importance, one was that casting hot involved a greater amount of liquid shrinkage, and the other that when such hot metal was provided the feeders were more effective. The correct way of feeding seemed to be not just a case of knowing where to put a feeder but also where to run the metal, and he thought that perhaps Mr. Hudson could enlarge upon that. There obviously was a need for some simple method of determining how a casting cools and solidifies.

MR. HUDSON said that in general the alloys used for lids of the type shown were nickel-copper alloys hardened with small additions of tin, silicon, manganese or iron. They had a relatively short freezing range in comparison with gunmetal and bronze and a high linear shrinkage, and must be cast on similar lines to steel, *i.e.*, relying upon temperature to provide an adequate measure of fluidity for feeding purposes. It was difficult to enlarge upon methods of moulding as suggested by Mr. Peace, as most of the types of lids in service had been covered. If any member, however, had a particular design of casting in mind which might be moulded by the methods described he would be pleased to comply with Mr. Peace's suggestion.

Cast-on Test-Bars

MR. DUNLEAVY said that several years ago he presented to the Branch the results of a few simple experiments with four phosphor bronze gear blanks. These castings were poured through a strainer core into a 1-in. down runner, then into a heavy well approximately 3½ in. dia. by 4 in. deep. The majority of the members considered this method had distinct possibilities, but unfortunately he had been unable to pursue the matter any further. Mr. Hudson had proved this theory in practice, a problem which a large number of people have been trying to solve for years. Controlled feeding under the conditions illustrated had certainly proved their value, and the most important feature seemed to be that the riser contained the hottest metal adjacent to the place where it was required. The riser metal was totally enclosed, and therefore free from contamination by the atmosphere. The methods suggested in the Paper ought to bear fruitful results in the future in the production of high nickel materials. He asked Mr. Hudson if it was the usual practice to ask for cast-on test-bars in Monel metal, and in particular for Monel metal impellers. Personally he did not think that it was advisable to attempt this. He believed that complete control of the metal composition was essential when making castings in Monel, as without the control results were variable.

MR. HUDSON replied that he was very pleased to have Mr. Dunleavy's confirmation of the moulding methods suggested. Regarding the question of test-bars in connection with Monel impellers, he thought it would be most unwise to attempt to produce "cast-on" bars.

Manganese Bronze Castings

MR. S. H. RUSSELL said he had been very interested in Mr. Hudson's Paper, because many works were producing quantities of manganese bronze castings which present many parallel problems. With this alloy, turbulence during pouring frequently had serious effects, and he was afraid that they could not adopt Mr. Hudson's method of top running in many cases. Referring to the illustration of the test-piece cast at the bottom of a large feeder, did Mr. Hudson think that a chill placed on the bottom of this test-piece would give an improved result? Mr. Russell endorsed the lecturer's remarks regarding the necessity of allowing sufficient taper on deep sections to permit progressive solidification and satisfactory feeding, and illustrated an example produced recently in the foundry using this method. He also expressed considerable interest in the plumbago wash used on the dry sand moulds, and was of opinion that the details given by Mr. Hudson were very helpful in producing a wash which would withstand the high temperatures of certain alloy castings.

MR. HUDSON agreed that the application of top running methods to high tensile brass might prove a practical proposition, particularly with those alloys containing a low aluminium content. A Paper by Higgins in the "Iron Age" (May 8, 1941) outlined the successful production of high-tensile brass castings by such methods, and it was particularly mentioned that no trouble had arisen through the presence of turbulence nor the formation of dross. Trouble might arise with those brasses containing appreciable aluminium contents, but top running methods would have to be tried out in order to confirm the matter. It would be extremely useful if some practical experiments on these lines could be undertaken by some of the members. Regarding the application of chills to test-bars, this was not usually necessary. If chills were used extensively on the casting they might be applied to the test-bars. Care should, however, be taken to prevent excessive chilling of test-bars made from alloys containing tin, as brittleness or low ductility might result.

Heavy Machining Allowances

MR. R. H. BUCKLAND suggested that it was rather amazing that it had been possible to allow ½ in. or more machining allowance on a number of machined surfaces. He was sure that some members would be pleased if similar tolerances could be accorded with cast and malleable iron. Monel metal was very expensive, and arising out of Mr. Dunleavy's remarks, apparently little or no attention was given to reducing feeder heads wherever possible. Surely the introduction of chills in the bottom of the mould, with the resultant increase in rate of solidification, would enable one to reduce the necessary size of feeder head. Mr. Hudson had referred to the objection of the engineers to the practice of casting in a pintle. Was the objection due to the fact that there was a possibility of the pintle working loose in service? If this were the trouble, it might be overcome by altering the method of running the casting, by introducing some hot metal into the bottom of the mould adjacent to the pintle. Perhaps Mr. Hudson would give his views on this point.

MR. HUDSON said the alloys used for steam valve lids were, as Mr. Peace pointed out, expensive to produce in the foundry and in the machine shop and accordingly every precaution taken to ensure good castings is in the long run likely to promote economic working. Short cuts to solidity by the use of chills were to be deprecated unless these were designed to assist progressive solidification. Furthermore, it should be understood that the technique of chilling as applied to cast iron did not work out in the same direction for non-ferrous alloys. In regard to pintles on valve lids engineers had, in the past, been afraid that these may come detached in service when joined by mechanical means. This objection was of course eliminated by "casting-in."

Cast-in Pintles and Gas Evolution

MR. E. HOLLAND wrote that he was particularly interested in the portion of the Paper dealing with test-bars and cast-in pintles. Regarding the former, the slides showing test-bars machined almost out of solid, seemed to indicate a very expensive method. Providing these were not more than 7 in. long, could not the recess be filled up, tapering from top to bottom and casting on end, thus ensuring a more evenly progressive shrinkage and a more regular shape for the initial machining? The clover-leaf pattern approached very closely to this, but was there not a possibility of uneven solidification between the outside of the leaves and the centre, as well as the waste of fuel in melting extra metal for the centre portion and extra metal in feeder head to feed this? It would be noted that the word uneven was used as against progressive, as where the cooling

(*Continued on page* 306.)

* See FOUNDRY TRADE JOURNAL for July 17, 1941.

The Applications of Titanium Oxide in Vitreous Enamels*

By S. G. TINSLEY, B.A., B.Sc. (British Titan Products Co. Ltd., Billingham, Co. Durham)

Introduction

Since the latter part of the nineteenth century, when titanium and its compounds were little more than laboratory curiosities, titanium oxide has been continuously studied with a view to its adoption as a desirable ingredient of vitreous enamels. Indeed, British Patent 9611, issued as long ago as 1893, recommends the partial replacement of the silica by titania in an enamel in order to improve its lustre and its resistance to corrosive attack. Furthermore, a high percentage of titania was claimed to yield an opaque glaze.

However, it was not until the year 1920, by which time its production on a commercial scale was firmly established, that titanium oxide was generally recognised as a beneficial ingredient in the formulation of acid resisting enamels and the development of its use in the vitreous enamel industry commenced seriously. To-day it is recognised that with titanium oxide it is possible to obtain workable enamels with a higher degree of acid resistance than can be obtained by any other means. More recently it has been found that titanium oxide, or compounds containing substantial proportions of it, can also develop a remarkable degree of opacity in special types of enamel frits. The contents of British Patent No. 427,850—May, 1935, British Patent No. 484,562—May, 1938, and British Patent No. 534,559—March, 1941, give some idea of the progress which has already been made in the development of mill addition opacifiers, containing substantial proportions of titanium oxide, by workers in America.

Before following the progress of these developments up to the present day, a short description of the preparation on the commercial scale, and properties of titanium oxide will be of interest.

Occurrence of Titanium

Although formerly considered to be one of the rarer elements, titanium is now known to be one of the most abundant and widespread. Indeed, it is estimated from surveys to comprise approximately 0.6 per cent. of known terrestial matter, coming after oxygen, silicon, aluminium, iron, calcium, sodium, potassium and magnesium, in order of abundance. It is found in traces in many rocks and minerals, and there are a few minerals which are substantially pure titanium oxide. Rutile, the only one of these having any commercial significance, contains from 90-98 per cent. of TiO_2, the chief impurities being iron oxides. The most important ore of titanium is ilmenite, a black mineral resembling coal dust in appearance, which is composed largely of titanate of iron, and which occurs in both rock and sand forms, the largest deposits being in India, Norway, Malaya, Australia, West Africa, North America and Brazil. The Indian deposits supply the ilmenite for approximately 80 per cent. of the world's production of titanium oxide and contain from 55-60 per cent. of TiO_2.

Manufacture of Titanium Oxide

In the development of a process for the manufacture of titanium oxide which took place in the early part of this century, several methods of extraction of the titanium oxide from ilmenite were tried, but all were eventually abandoned in favour of the method now employed—the direct decomposition of the ore with sulphuric acid. After digestion, the mixture of titanium and iron sulphate is dissolved in water and the solution clarified. Titanium hydroxide is then precipitated by hydrolysis at elevated temperatures and carefully purified by a series of filtration and washing operations. In order to prepare a satisfactory titanium oxide pigment from this hydroxide, it is necessary not only to convert it into anhydrous oxide, but also to ensure that this is in the right physical condition. To achieve this end the hydroxide is calcined under rigorously controlled conditions, and the product is subjected to intensive milling. By carefully regulated hydrolysis, purification, calcination and milling procedures, the titanium oxide is endowed with the optimum pigmentary properties.

Properties of Titanium Oxide

The commercial grade of titanium oxide as prepared by the above method is an intensely white, fine powder having the high refractive index of approximately 2.7 and an average particle size of about half a micron, or 0.0005 mm. These properties are responsible for its present position as the strongest white pigment known, and its consequent popularity in the pigment consuming industries.

Of more immediate interest to the vitreous enameller, however, are the chemical properties of titanium oxide. These are closely allied to those of silica as would be expected from the fact that titanium and silicon are both members of the fourth group of the Periodic Table. Thus, titanium commonly exerts a valency of 4, and its hydroxide is amphoteric, combining with acids to form titanium salts and with alkalis to form titanates. At ordinary temperatures, the oxide is extremely stable and comparatively inert, physically, chemically, and physiologically. Generally, the use of elevated temperatures together with strong reagents, both acid and alkaline, are necessary to effect combination. Thus fusion is necessary in order to bring about combination with alkalis.

The titanates are quite analogous to the silicates and the two kinds of salts are isomorphous. Titanium oxide replaces silica isomorphously in many minerals, but does not form a series of salts of such complexity as the latter. Nevertheless, a considerable number of titanates are known; for instance, a series of sodium titanates having the formulæ $2Na_2O.TiO_2$, $Na_2O.TiO_2$, $2Na_2O.3TiO_2$, $Na_2O.2TiO_2$, and $Na_2O.3TiO_2$ has been described.[1]

A series of titano-silicates corresponding to the formula $RxO.yTiO_2.zSiO_2$ can also be prepared, and Mellor[2] gives the composition and physical properties of a number of minerals which are all complex titano-silicates. Since soda is the principal alkali in almost any enamel formula, a few words about sodium titano-silicate corresponding to the formula $Na_2O.TiO_2.SiO_2$ will be relevant. This compound is a glass and can readily be made by fusing the required amounts of TiO_2 with a mixture of soda ash, sodium nitrate, sodium silicate and silica. Fusion is quite rapid and the glass is very mobile at 1,100 to 1,200 deg. C., at which temperature most enamels are smelted.

Acid-Resisting Enamels

The importance of the property of acid resistance to the vitreous enamel industry as a whole needs no emphasis. The vitreous enamel finish, by reason of its versatility of application, excellent appearance and durability, is continually finding new utility in ways not dreamt of a few years ago. For instance, its application to architectural work is an enormous field still practically unexplored as far as this country is concerned.

In many of the newer uses, porcelain enamel is taking the place of older established finishes and materials, and its merits will be judged by its relative performance when compared with the finish or material it replaces. It is obvious that if the resistance of the enamel to corrosive attack and weathering is poor, the prestige of the whole industry will eventually suffer. Furthermore, vitreous enamel should be ready to hold and improve its present reputation as the finish *par excellence* for the whole range of domestic appliances, in the days of intense competition which will inevitably follow the war when the aluminium industry, with a production capacity enormously expanded by wartime needs, will exert an energetic drive to capture this market. Vitreous enamel can more than hold its own if its quality is maintained, and improved durability is one of the most important factors contributing to quality as a whole.

An increased resistance of any enamel to the attack of corrosive solutions, such as acid solution, fruit juices, rain water in industrial areas, and so on, can be effected by raising its silica content at the expense of the alkali and fluorine compounds. However, an enamel formulated in this way is invariably more difficult to work satisfactorily on account of its much diminished fusibility and the fact that high silica, low alkali enamels have a low coefficient of expansion. By replacing from 6 to 10 per cent. of the silica in such a formula by titanium oxide, however, a much more mobile enamel having the same acid resistance and a higher coefficient of expansion is obtained. The titanium oxide is added to the batch and intimately mixed with the other ingredients. During the smelting it acts as a secondary flux. It is probable that it is first attacked by the molten soda and later by sodium silicate to form sodium titano-silicate, which is a very mobile fluid at the smelting temperature, and, therefore, a good flux. Amounts in excess of 10 per cent. of titanium oxide tend to cause a decrease in the fusibility in the conventional type of enamel containing approximately 20 per cent. of alkalis, although very fusible, special types of acid-resisting

* Paper read at the Eighth Annual Conference of The Institute of Vitreous Enamellers held at Birmingham on November 1, 1941.

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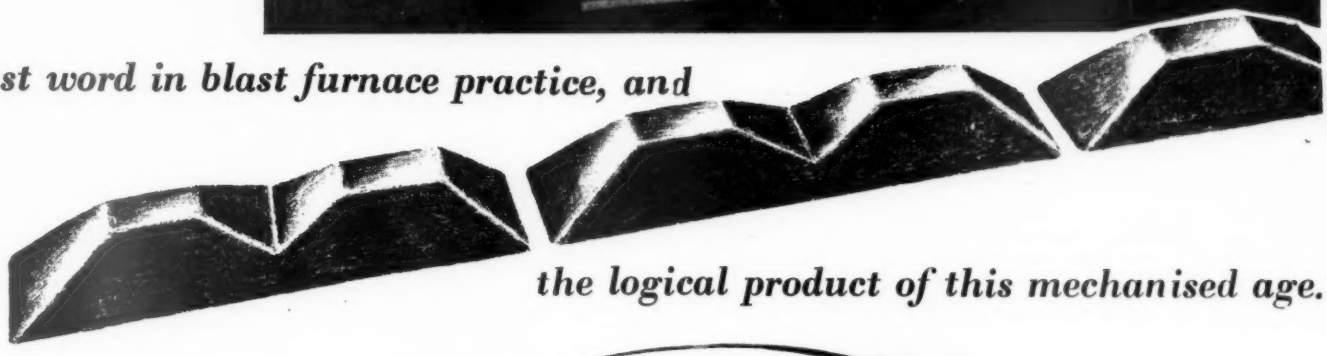

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Titanium Oxide in Vitreous Enamels

enamel containing up to 18 per cent. of titanium oxide have been used. The Mayer and Havas expansion factor for titanium oxide is 4.1, as compared with 0.8 for silica. It is easy to see, therefore, why the replacement of silica by titania raises the coefficient of expansion of an enamel and improves its ease of application. Moreover, it is usually found that a proportion of titanium oxide in the frit improves the gloss of the fired enamel.

In formulating enamels designed to resist the attack of aqueous solutions containing organic and inorganic acids met with domestically, the following points are usually observed:—

(*a*) The combined alkali content (Na_2O + K_2O) of the frit should not exceed 20 per cent.

(*b*) The minimum silica content should be between 45 and 50 per cent.

(*c*) Between 8 and 10 per cent. of titanium oxide should be present. This, together with the silica, imparts acid-resisting qualities which would be expected in an enamel containing from 53 to 60 per cent. of silica.

(*d*) The boric oxide content of the frit should not be higher than 10 per cent. since this oxide lowers both the coefficient of expansion and the acid resistance when present in large amounts.

(*e*) The remaining 10 to 17 per cent. of the oxide composition is made up substantially of aluminium from the felspar together with small amounts of fluorine compounds, calcium oxide, zinc oxide, etc. The fluorine compounds, cryolite, fluorspar or sodium silicofluoride, should not amount to more than 3 per cent. of the raw batch since all of these have a marked effect in lowering the acid resistance of ordinary commercial enamels when present in larger proportions.

Enamels containing titanium oxide often suffer from the disadvantage of possessing a cream colour. This discoloration is due to the development of a strongly coloured compound of titanium and the iron present in the mineral constituents of the batch, e.g., the felspar and the quartz, and is particularly marked when smelting takes place in the absence of oxidising conditions. A small proportion of sodium silicofluoride in the batch is often recommended as a means of eliminating this discoloration, but the author has found that the maintenance of an oxidising atmosphere during the smelting operation is a more reliable cure. This can be effected by using a greater proportion of sodium nitrate in the batch formula in place of an equivalent amount of sodium carbonate. Potassium nitrate is even more effective than sodium nitrate in this respect. The yellow colour is not developed in the absence of iron impurities and although the use of raw materials completely free from iron is impossible in practice, this point should not be overlooked when selecting sources of supply.

The following is a typical example of an ordinary, easily fusible, transparent acid-resisting enamel containing titanium oxide, for use on sheet iron and steel.

Frit K. 231.

Felspar	28.0
Borax	22.0
Quartz	25.0
Sodium carbonate	6.5
Sodium nitrate	7.0
Sodium silicofluoride	3.0
Titanium oxide	8.5
	100.0

This enamel can be smelted readily at 1,150 deg. C. to a colourless frit, has good working properties, and a good firing range around 800 to 850 deg. C. The enamel surface is remarkably resistant to attack by solutions of organic and inorganic acids and is not etched by lemon juice. When tested according to the method recommended by the Chemical Resistance Test Sub-Committee of the Joint Committee on Vitreous Enamelling,[2] the loss in weight after one hour's attack by 3 per cent. oxalic acid, is 15 to 20 milligrams per square decimetre. Similar principles apply to the formulation of enamels for use in both the wet process and the dry process on cast iron. It is imperative that an acid resisting frit be used for coloured baths as otherwise differences in colour soon develop between those portions of the surface above and below the usual hot water level, resulting in a disagreeable appearance.

Enamels for Chemical Plant

Vitreous enamels designed for the lining of plant to be used in the manufacture and storage of chemicals which exert a vigorous corrosive action on metals, or those which must be completely protected from contamination by the metal with which the processing or storage vessels are fabricated, approach the composition of glass more closely than the softer type of enamel used on domestic-ware, sign plates, and for decorative work. In fact, the finished article is often described as "glass-lined." The enamels may contain up to 65 or even 70 per cent. of silica and this together with a low content of alkaline fluxes makes for an enamel with low fusibility and low coefficient of expansion, which is applied to the metal surface with great difficulty as a consequence. Once again the use of titanium oxide in the batch provides a remedy for these difficulties and, at the same time, improves the acid resistance. The results in Table I show the effect of adding 10 per cent. of titanium oxide to the composition of an enamel of this type on its resistance to attack by boiling 10 per cent. HCl solution.

TABLE I.

Batch.	M1	M 2	M9
Borax	15.9	14.4	2.6
Quartz	17.1	14.4	19.2
Sodium silicate	51.0	48.3	51.3
Clay	4.9	4.4	—
Sodium aluminate	—	—	5.3
Sodium nitrate	4.3	3.2	1.1
Whiting	6.8	6.4	2.2
Fluorspar	—	—	3.0
"Kronos" titanium oxide	—	8.9	15.3
	100.0	100.0	100.0
Percentage composition of oxides.			
Na_2O	19.0	17.1	15.8
CaO	4.4	4.1	1.2
CaF_2	—	—	3.4
Al_2O_3	2.2	2.0	2.9
B_2O_3	6.7	6.0	0.9
SiO_2	67.7	60.7	60.0
TiO_2	—	10.1	15.8
	100.0	100.0	100.0
Calculated coefficient of expansion	2.78	2.93	3.00
Smelting temperature	1,150° C.	1,150° C.	1,150° C.
Firing temperature	850° C.	850° C.	850° C.
Gloss	Poor	Good	Very good
Loss in wt. after 8 hours attack by boiling 10 per cent. HCl. aq.	0.63 mg/cm²	0.20 mg/cm²	0.04 mg/cm²

M.9 is an enamel formulated so as to allow the inclusion, approximately 16 per cent., of titanium oxide, and the loss in weight figure has been reduced to negligible proportions. It will be noticed that titanium oxide improves the gloss of the enamel, thus lowering the area of surface exposed to attack.

Titanium Oxide as an Opacifier

The opacity of any enamel is determined by the degree to which the light falling upon it is scattered or diffused by particles embedded in the glassy matrix. The amount of scattering depends upon the difference between the refractive index of the glass and that of the particles embedded in it, and on the number and size of these particles. The greater the difference between the refractive index of the particles and that of the glass, the greater is the extent of the bending induced when a ray of light passes from the glass into the particle. Furthermore, a high degree of reflection from the particle back into the glass takes place. In a layer of enamel containing opacifier particles, this transition from glass to particle occurs many times even in a thin layer. The result of the particle having a higher refractive index is that the scattering of the incident light is high and the background of dark coloured ground coat is hidden more completely than would be the case if the refractive index of the particles approached that of the enamel itself more closely. Moreover, the nearer the diameter of the particles approach the wavelength of the incident light, the more frequently does the light meet an interface between opacifier and glass, and more scattering is induced in a layer of given thickness, which again results in an intensification of opacifying power. If the particle diameter is much less than the wavelength of light, opacifying power decreases.

Titanium oxide has a refractive index of 2.5 to 2.7 as compared with 2.4 for zirconium oxide, 2.04 for tin oxide, 2.2 to 2.35 for antimony trioxide and 1.50 to 1.55 for most enamel glasses. Furthermore, its average particle has the very small diameter of about half a micron. It is not surprising, therefore, that it was anticipated that titanium oxide would behave as a very powerful opacifier in vitreous enamels and thus assume in the industry the importance it possesses in the manufacture of paint and other pigmented products.

Thus, in addition to the patent taken out in 1893 already mentioned, others were issued in 1900 and 1907 covering its use as a mill addition to the frit in order to opacify an enamel in exactly the same way as tin oxide. Unfortunately, such attempts to produce opacity were doomed to failure on account of the ease with which the titania dissolved in the enamel matrix to form transparent titanates during firing.

However, when the production of titanium oxide on the large scale was well established and large and regular supplies were available at a price considerably less than those of the opacifiers in common use, the problem of preventing the solution of the oxide by the enamel was tackled in earnest.

The effect of the composition of the frit on its power of dissolving titanium was studied and it was found that enamels high in silica and low in alkali and fluorides had a much diminished dissolving power. Thus, a transparent frit having a formula on the lines Frit K.1 gives reasonably good opacity in two coats with an addition of 8 per cent. of titanium oxide at the mill.

Frit K.1.

Felspar	30.0
Borax	22.0
Quartz	25.0
Sodium carbonate	10.0
Sodium nitrate	2.5
Whiting	7.0
Zinc oxide	3.5
	100.0

However, to obtain good opacity even with these special frit compositions it was necessary to use the minimum time and temperature for the fusion process in order to prevent loss of opacity due to some of the titanium oxide dissolving. Such a degree of control, though easily attained in the laboratory, proved impossible in large scale plant fusion operations.

(*Continued on page* 306.)

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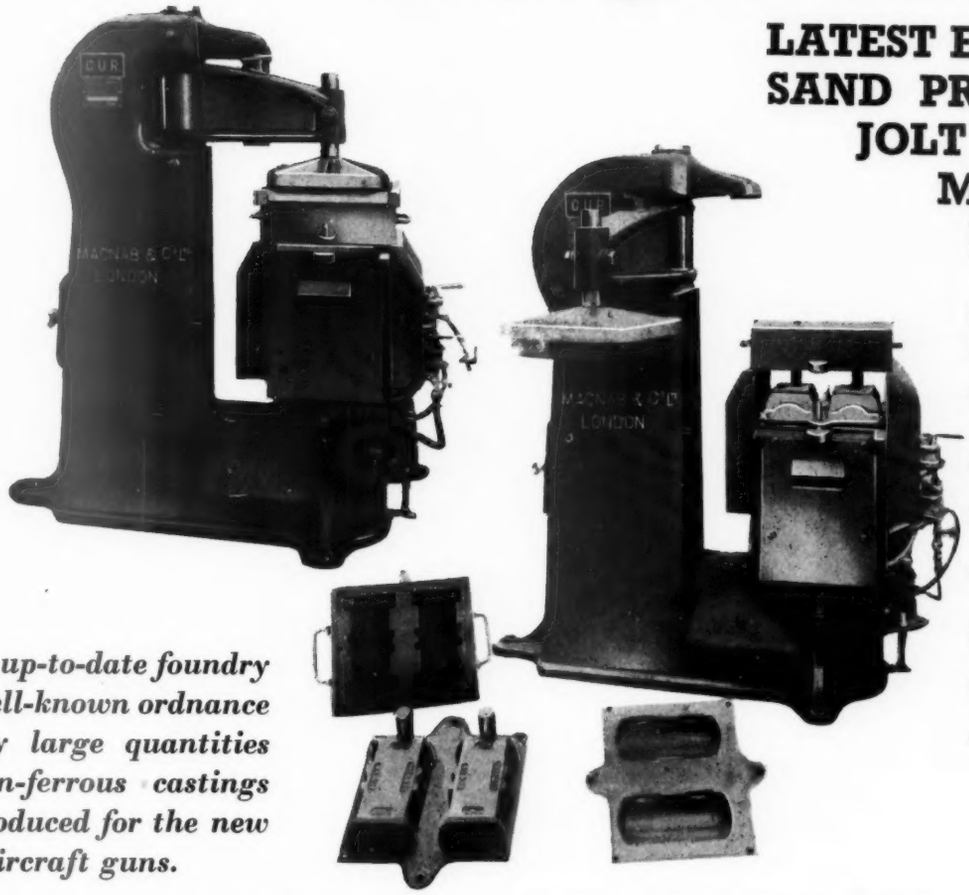

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Non-ferrous Steam Valve Lids

(*Concluded from page* 301.)

range was quickest there would be a denser structure than where this was delayed in spite of progressive solidification.

With regard to the inserted pintle, he would be interested to learn whether there was not a danger of gases being generated from this steel insert at the high pouring temperature of the metal. Mr. B. Hird in a Paper entitled "Grey Iron Problems," given before the Branch and printed in THE FOUNDRY TRADE JOURNAL of November 28, 1940, dealt with this problem with reference to steel inserts in cast iron. If Mr. Hird's theory was correct, then it must occur in any metal at a sufficiently elevated temperature.

MR. HUDSON, referring to test-bars, said it was doubtful as to whether any advantage would be gained by vertically casting even if the bars were well tapered unless large diameters were employed and the machining of these down to size would be just as expensive as those shown in the Paper. In small diameter vertically-cast bars the primary crystals formed tended to obstruct feeding action and difficulty was likely to be experienced in getting the centre sections sound. Accordingly the bar would have to be made, having a diameter large enough to ensure that the growth of the primary crystals did not interfere with feeding. Furthermore, the variation in section of a vertically-cast taper bar would probably give rise to a variation in structure along its length with consequent erratic results on test. Reference might well be made to Kain and Dawson's Paper, Proc. I.B.F., 1939-40, page 61, mentioned in connection with the development of the clover-leaf pattern. In regard to the "cast-in" pintle, there would be little danger of gases being generated when using a Monel or stainless steel (18/8) pintle. If a steel containing appreciable carbon content was employed, trouble might be experienced due to gas.

Vote of Thanks

MR. PEACE, in proposing a vote of thanks, expressed the opinion that the methods of feeding suggested by Mr. Hudson's Paper would prove of immense value in the production of high-duty castings. It was unfortunate that censorship had withheld some of the details so essential to a discussion on foundry practice, but the members had no doubt improved their knowledge in running and feeding methods of this particular procedure.

MR. DUNLEAVY seconded the vote of thanks, saying he was pleased that Mr. Hudson had endorsed all his views in the necessity of close control of all raw materials when producing high-duty nickel alloys, and on behalf of all members he heartily seconded the vote of thanks, which was carried with applause.

MR. HUDSON replied, saying it gave him great pleasure again to visit the East Midlands Branch and, as the discussion had been curtailed owing to return train arrangements, if any members cared to ask further questions by correspondence he would be pleased to answer them.

Die-Cast Metals and Alloys

The Report of the A.S.T.M. Committee B-6 on die-cast metals and alloys, by J. R. Townsend, submitted at the recent Chicago meeting, presents an immediate revision in the chemical composition requirements for alloy XXV of the specifications for zinc-base alloy die castings. The atmospheric exposure test research programme on zinc-, aluminium-, and magnesium-base alloy die castings, which has been under way for over 12 years, is to be continued. The report also discusses briefly the work on study of effects of minor alloying elements on aluminium-base alloys, creep studies on tin- and lead-base alloys, and fatigue strength of zinc-base die castings, also a new magnesium-base alloy under consideration.

The Applications of Titanium Oxide in Vitreous Enamels

(*Continued from page* 304.)

It will be noticed that the conditions outlined above for decreasing the tendency towards solution of the titanium oxide are exactly similar to those which hold for the development of good acid resistance. It seemed reasonable, therefore, to expect an enamel that already contains from 8 to 10 per cent. of titanium oxide dissolved in the frit for the purpose of improving its acid resistance to show a decreased tendency to dissolve a further amount of titanium oxide added at the mill in order to give it opacity. Experiments showed that this was the case. Thus, Frit K.21, a typical acid-resisting enamel containing titanium, develops excellent opacity with two coats when 7 per cent. of titanium oxide is added at the mill. It was found that the same principles could be extended to the softer enamels which are not acid resisting in the usually accepted meaning of the term. Frit K.20 is an example of this type of enamel, containing approximately 10 per cent. of titanium oxide in the frit composition, which can be opacified with an addition of 6 per cent. at the mill. When applied in one coat at 50 grms. per sq. ft., a brightness of 57 per cent. is obtained, which is increased to 68 per cent. with a further application of the same weight. The batch formulæ of K.20 and K.21 are given in Table II.

TABLE II.

	Frit K.21. Acid-resisting.	Frit K.20. Non-acid-resisting.
Felspar	18.6	29.2
Borax	19.3	25.8
Quartz	24.9	19.4
Sodium carbonate	8.1	5.3
Sodium nitrate	9.7	6.5
Cryolite	—	3.0
Fluorspar	—	2.8
Sodium silicofluoride	1.7	—
Clay	2.6	—
Whiting	6.3	—
Titanium oxide	8.8	8.0
	100.0	100.0

(*To be continued.*)

Magnesium Sand Castings

The largest magnesium sand casting produced in quantity in the United States is a magnesium alloy pump base weighing 1,000 lbs., manufactured by the Dow Chemical Company.

American Vitreous Enamellers

The United States vitreous enamelling industry, faced with large-scale curtailment in operations due to materials shortages occasioned by defence programme requirements, has formed a War Operations Committee to safeguard raw material supplies. A study of porcelain-enamelled products that might carry priorities has also been started. Numerous suggestions have been offered, both to keep the industry occupied in the current emergency and as a means of cushioning the return to eventual peacetime production. Substitution of defence items to fill empty capacity is being studied.

Titanium Ore Developments in U.S.A.

The National Lead Company of N.Y. has purchased 4,000 acres of land at Tahawus, N.Y., where they will mine ilmenite. Production is expected to be well in hand by next summer. The O.P.M. has granted the company priority on all equipment needed on the understanding that the ilmenite be available to other titanium manufacturers. The Adirondack magnetite-ilmenite deposits were discovered in 1908, but were never developed until the present emergency prevented imports of ilmenite from India and Africa. The National Lead Company estimates that the deposit will yield enough ilmenite to supply the whole U.S. titanium products industry for ten years.

Fuels and Furnaces for the Heat Treatment of Steel Castings

(*Continued from page* 299.)

difficulty can be overcome by using a preliminary crusher which is supplied with large coal up to cobbles size, in which the moisture content is always very much lower than in washed singles. In winter, any wagons covered with snow must be allowed to stand in the shop until the snow has melted and the water drained away, before the coal is charged into the crusher. In some districts it is now possible to buy coal ready pulverised and dry, thus eliminating the necessity for installing a pulverising system at the consumer's works.

With pulverised fuel, the control of furnace atmosphere and temperature is much easier than when coal is burned on the grate, though less easy than with gaseous fuels. There are, however, several disadvantages attending the use of pulverised fuel. The flame temperature is high, leading to a high maintenance cost for the combustion chamber, where ash at high temperatures is liable to attack the refractories. The furnaces must be periodically shut down for removal of slag and ashes, whilst the occurrence of layers of ash on the steel charge, and its distribution over the surrounding locality, are sometimes a nuisance. Unless special care is taken there are leakages of coal dust into the shops and this dust, settling on girders, crane motors and in numerous other places, increases the fire hazard and makes it difficult to keep the shops clean. In addition, the use of recuperators or regenerators is not practicable when pulverised fuel is being burned.

(*To be continued.*)

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

537,693 KING, A. J., ARMOUR, A. M., and METROPOLITAN - VICKERS ELECTRICAL COMPANY, LIMITED. Demagnetising and also the magnetising of articles.

537,700 GIBBONS BROS., LIMITED, MARLE, M. VAN, and WEBB, A. W. OGILVY-. Furnaces for the heat-treatment of metal.

537,708 HATFIELD, W. H., and GREEN, H. Chromium-nickel steel alloys.

537,711 FELIX, B. B. C. Rail joints.

537,870 WELLMAN COMPANY, S. K. Method and apparatus for making bodies of compacted powdered material.

537,973 BRITISH FEDERAL WELDER & MACHINE COMPANY, LIMITED, and WOLTON, H. W. Welding of tubular or cylindrical articles.

538,019 DUREX ABRASIVES, LIMITED. Methods of preserving abrasive coated material.

538,050 RUDOLF, H. T., and BRASSERT & COMPANY, LIMITED, H. A. Mud-guns.

538,055 SULZER FRERES SOC. ANON. Cast metal parts.

538,075 NORTH BRITISH ELECTRIC WELDING COMPANY, LIMITED, and GLOVER, T. S. Manufacture of chain links.

538,092 LINDE AIR PRODUCTS COMPANY. Methods of seaming or de-surfacing of metal bodies.

538,104 INLAND STEEL COMPANY. Steel.

538,179 WHITE, JUN., T. T. Apparatus for testing tension of wire ropes.

538,210 STEVENS, A. H. (Heatbath Corporation). Imparting of colour finish to iron and steel articles.

538,226 PITTER, W. C. Seizing devices, more particularly applicable in locating and salvaging submerged articles or structures of ferrous metals.

538,241 BUDD INDUCTION HEATING, INC. Treatment of metal articles to change a dimension thereof.

538,262 SANDBERG, C. P., SANDBERG, O. F. A., and HUMFREY, J. C. W. Manufacture of railway and tramway tyres and solid wheels.

538,290 SIEMENS-SCHUCKERT (GREAT BRITAIN), LIMITED, and DITSCHLER, F. H. Lifting and traversing mechanism for furnace covers.

IS YOUR PRODUCTION BEING STIFLED ?

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The Week's News in Brief

Trade Talk

VITREOUS ENAMEL PLAQUES are now being used by the American paint industry as colour testing media!

STAGGERED HOURS OF WORK are to be introduced by North-East Coast shipbuilding and engineering works to ease passenger transport during the winter months.

THE ENGINEERING EMPLOYERS have rejected the claims of the unions in the industry for wage increases. The claims will now presumably be argued before the National Arbitration Tribunal.

WITH THE APPROVAL of the King, the Ministry of Works and Buildings proposes to remove about 100 more tons of iron railings from the royal parks. Already 1,204 tons of scrap has been given up by the royal parks.

MR. E. M. RICH, late Education Officer, London County Council, will read a Paper on "Technical Education" at a meeting of the Royal Society of Arts, London, W.C.2, on Wednesday, November 12, at 1.45 p.m. The Rt. Hon. R. A. Butler, M.P., President of the Board of Education, will preside.

SCUNTHORPE STEELWORKERS have signed a petition which they have sent to the local Citizens' Advice Bureau asking for more clothes and boots coupons owing to the heavy nature of their work. The Bureau has forwarded an appeal to the Board of Trade on behalf of these men, and has suggested that steel furnacemen have grounds to be included in the same category as miners, quarrymen, and agricultural labourers in relation to extra coupon grants.

ACCORDING TO LORD BEAVERBROOK, Minister of Supply, Britain has promised Russia supplies of aluminium, copper, lead, zinc, tin, cobalt, brass, and phosphorus among other materials. Among raw materials Russia will send to us are chrome, potash, magnesite and potassium. Steel, phosphates and large quantities of machine tools also are being despatched to Russia. Lord Beaverbrook said we had plenty of raw materials in Great Britain. Where we were perishing for them 18 months ago, we now had a surplus of supplies. We had enough machine tools, a new situation in which we had a right to rejoice. We still required a replenishment of our machine tools to take the place of those worn out. Our machine-tool plant was adequate, provided we got additional tools from the United States. With ample raw materials, enough machine tools and plant, it only remained to recruit labour to the fullest extent.

REPRESENTATIVES OF THE SHIPBUILDING Employers' Federation and of the Confederation of Shipbuilding and Engineering Unions resumed their wages conference at Carlisle last week, when further consideration was given to the application submitted to the unions for a substantial increase in wages. Mr. J. M. Ormston, the president of the Shipbuilding Employers' Federation, explained that, after careful consideration of the full case made by the unions, the employers had been unable to satisfy themselves that anything had happened since January which called for an adjustment in the award then made by the National Tribunal. Mr. J. W. Stephenson, chairman of the Shipyard Group Council of the Confederation of Unions, on behalf of the unions, said that they were disappointed with the industry's reply to their application, and that the matter would be referred to the executives. In January last, it will be recalled, the Tribunal awarded an advance of 3s. 6d. per week.

MR. ERNEST BEVIN, Minister of Labour and National Service, met the Joint Consultative Committee of the British Employers' Confederation and the general council of the T.U.C. last week, when the man-power situation was reviewed and a general discussion took place. Sir John Anderson, Lord President of the Council, speaking in London the same day, said there had been a great deal of ill-informed criticism about production and the use of man-power. Many people asked if we had a plan. The answer was in the affirmative, but it was impossible to talk in public about our plans without talking to nearly every country in Europe. He denied that we were not planning in the production sphere all that it was possible to plan. Any plan we made had to be elastic. More and more people outside the normal working strength of the community must give their services to the State. The number of men engaged in war industry after two years of this war had been increased by almost the same amount as for the whole period of the last war. For the new demands made there must be a great response by the women of the country. If he could tell what we had supplied to Russia and what we were going to supply Russia with his audience would be amazed, and if he were to give the equivalent in terms of man-power they would find the figure was staggering.

Personal

MR. WILLIAM NITHSDALE, formerly director of Yarrow & Company, Limited, has been appointed to the board of Richardsons, Westgarth & Company, Limited.

MR. A. C. SHEPHERD has been appointed chairman of Mann, Egerton & Company, Limited, engineers, following the death of Mr. G. N. C. Mann, the founder, chairman, and managing director of the company.

MR. D. G. SINFIELD, manager of the Walkergate welding works, Newcastle-upon-Tyne, of C. A. Parsons & Company, Limited, has been installed chairman of the North-Eastern (Tyneside) Branch of the Institute of Welding.

DR. G. G. M'DONALD, lecturer in Engineering at Glasgow University, has been awarded the Gold Medal of the Institution of Engineers and Shipbuilders in Scotland for his Paper, "Dimensional Analysis of Centrifugal Pump and Blower Performance."

MR. CHRISTOPHER STEPHENSON has been appointed general manager of the Hebburn shipbuilding yard of R. & W. Hawthorn, Leslie & Company, Limited, in succession to the late Mr. W. R. Hutton. Mr. George H. Todd, who has been with the company for 21 years, has been appointed manager of the shipbuilding yard.

Wills

RICHARDS, R. P., of Merioneth, late a director of the Vulcan Foundry, Limited	£40,380
HALEY, H., director of William Barraclough, Limited, light castings manufacturers, of Stanningley, Leeds	£8,722
MAINWARING, HENRY, brassfounder, Charles Street Brass and Copper Works, Chorlton-on-Medlock, Manchester	£9,296
MEARS, E. J., of Birmingham, director of the Steam Gauge Manufacturing Company, Limited, West Bromwich	£3,633
CHAMBERLAIN, ARTHUR, chairman of Tube Investments, Limited, and a director of the General Electric Company, Limited, and other undertakings	£310,683

Obituary

MR. JAMES DOWNS, former chairman of Rose, Downs & Thomson, Limited, engineers, has died at Hull at the age of 85. He was a former president of the Hull Chamber of Commerce and Shipping.

MR. W. J. SMALLWOOD, general sales manager and director of the Skinningrove Iron Company, Limited, has died as a result of enemy action. Mr. Smallwood was in his 51st year, and had been with the company for over 28 years.

MR. LEVI MAIDEN, of Hyde, who was engaged all his working life at Maiden & Company, Limited, tool makers and engineers, of Hyde, Cheshire, and was a director for many years until his retirement, died on October 22, aged 74.

MR. LAWRENCE NAPIER LEDINGHAM died at his home in Sheffield on October 25. Mr. Ledingham was for some years chief chemist for William Jessop & Sons, Limited, Brightside Works, Sheffield. In 1902 he founded the firm of L. N. Ledingham & Company, Limited, Leadmill Street Steelworks, Sheffield. An Alderman since 1932, he retired from the Sheffield City Council last February after 27 years' service.

Contract Open

Cheadle, November 12—Approx. 1,020 yds. of 4 in. dia. spun-iron water main, for the Rural District Council. Mr. J. W. Burton, engineer, Council Offices, Cheadle. (Fee £1 1s., returnable.)

Heavy Labouring Occupations

RESERVATION AT 35

The following heavy labouring occupations become reserved for the first time under changes in the Schedule of Reserved Occupations announced by the Ministry of Labour on Tuesday, the age of reservation until further notice being 35: Shipyard labourer (general), ship scaler, boilershop labourer (general), cupola man (charger) (iron and steel), labourer (scrap metal yard), labourer (bolt, nut, rivet), scrap breaker, cutter up (scrap metal), stacker and/or bundler (scrap metal), engine shed labourer (railway), labourer (coal gas, coke oven plant), and underground labourer (oil shale mine). Foundry labourers (general hands) (non-ferrous) also become reserved at age of 35 until further notice, if they are employed in protected establishments, but not otherwise. These new reservations are not retrospective in their effect; they do not involve the release of men now serving in H.M. Forces or of men who have already received enlistment notices.

Hitherto labourers have not, as a rule, been reserved, since labouring occupations require physical strength rather than skill. The point has now been reached, however, when the work of skilled men is being handicapped by shortage of labourers. This has been noticeable particularly in the iron and steel industry and the scrap trade.

Certain shipyard workers are to continue to be reserved until further notice at their existing ages of reservation, instead of at the age of 23 as was proposed at Stage C of the current Schedule: Boilermaker's helper or labourer; and ship plater's helper to continue to be reserved at age 18; rigger's labourer to continue to be reserved at age 21.

The following occupations under the heading of "scrap metal worker" are to continue to be reserved at age 25 until further notice, instead of at the age of 30 as was proposed at Stage C of the current Schedule: Foreman, charge hand; scrap sorter.

Steel Exports under Licence

Under a Board of Trade Order which comes into force on November 6, licences will be required to export to all destinations a number of additional forms of iron and steel (including alloy steel) and of articles manufactured wholly or mainly of iron or steel. The Order (S.R. & O., 1941, No. 1615) also extends the existing prohibitions relating to machine and other tools, paper-insulated wire and cables, mining drill bits, certain types of railway locomotives and vehicles.

Copies of the Order are available at H.M. Stationery Office and through booksellers, price 2d. net. It contains an up-to-date list of the iron and steel and non-ferrous products to which restrictions now apply.

Reports and Dividends

Thomas Blackburn & Sons—Dividend of 6% (same).

Thompson Bros. (Bilston)—Final dividend of 7½%, making 15% (same), and a bonus of 5% (7½%), making 20% (22½%).

Cornercroft—Net profit, after tax, for the year to June 18 last, £23,948 (£28,750); final dividend of 9% on the ordinary shares, making 15% (same).

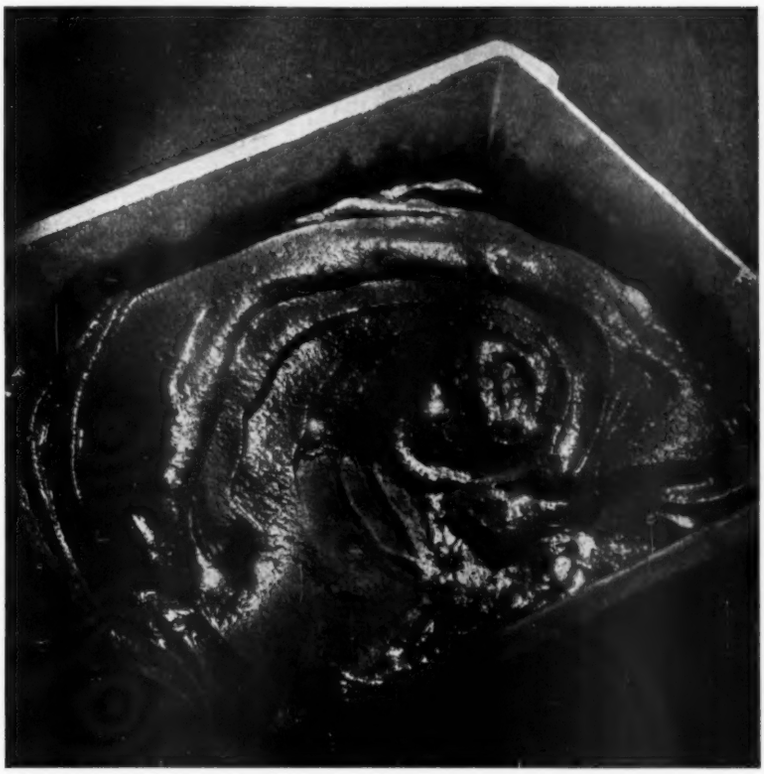
Crabtree Electrical Industries—Final dividend on the ordinary shares of 5%, plus cash bonus of 7½%, making a total distribution of 17½% (same) for the year ending October 31.

Herbert Morris—Trading profit for the year ended July 31, £101,694 (£153,750); from investments, £6,960 (£9,733); depreciation, £15,738 (£17,092); further dividend on the ordinary shares of 15%, making 20% (same), free of tax; forward, £64,703 (£82,476).

Ferranti—Profit for the year to June 30, after taxation, £172,155 (£141,693); to depreciation, £79,437 (£61,438); war damage insurance, £11,222; to contingency reserve, £20,000 (same); ordinary dividend of 6% (same), free of tax; forward, £74,482 (£68,200).

Horseley Bridge & Thomas Piggott—Trading profit to June 30, after charging debenture interest, depreciation, War Risks insurance, A.R.P. expenditure, etc., £117,506; reserve for income tax and E.P.T., £81,000; net profit, £36,506 (£38,833); dividend on the 5% preference shares, £1,372; dividend of 12½% (same) on the ordinary shares, £14,062; reserve for contingencies and deferred repairs, £10,000; forward, £36,698 (£25,626).

Watch this Dictator of Firebrick Life



THERE are some users of refractory bricks who are curiously careless as to the cement they employ. Whilst insisting upon sound and suitable bricks they build them with an inferior cement. They let cement dictate the life and durability of refractory bricks. The shrewd refractory user knows that a dependable cement is worth its cost many times over. Experience shows that in structures jointed with ordinary fireclay, extensive erosion originates in the joints. Joints made with any of the following cements are as hard and mechanically strong as the firebricks.

DURAX No. 3 is a 42/44% alumina, air-setting, high temperature jointing cement suitable for bonding firebrick linings working under high duty conditions. A special feature of Durax No. 3 is its fine grading, which not only gives the cement good "workability" and makes it easy for the mason to use, but also permits a brick-to-brick joint which is so desirable in furnace construction. To obtain the maximum length of service from your firebrick linings, specify Durax No. 3 Refractory Cement for jointing.

PYROLYTE H.T. CEMENT (air setting) for jointing basic bricks in re-heating furnaces, and also for jointing and wash-coating firebricks where furnace conditions produce erosive slag.

DURAX No. 3 REFRACTORY CEMENT (air setting) for jointing and wash-coating all types of firebricks, working under normal and high duty conditions.

SINTEX "D" AND "W" (air setting) for jointing siliceous and semi-siliceous bricks, and also for patching gas retorts and coke oven linings.

GENERAL REFRACTORIES LTD.

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G.P.19

FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol.*

INSULATION: *Amberlite* Bricks, Cement and Concrete. SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.* CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister, Steel Moulders' Compositions.* SILLIMANITE: Tank Blocks, Bricks and Cements. SANDS: Moulding, Brick Facing, Silica, Glass.

Raw Material Markets

Output of high-phosphorus iron is easily able to satisfy all demands, and deliveries are made promptly. There is no great pressure for this type of iron, and licences are granted freely. Stocks of many consumers are as large as can be accommodated for the time being. High-phosphorus iron is now more extensively used by makers of heavy castings, owing to the comparative shortage of better quality irons, and this to some extent makes up for the substantial decline in the demand from the light foundry industry, which continues to be in need of much additional business. There has lately been an increase in the output of hematite, but this material remains as difficult as ever to obtain, and the Control will only release supplies to users engaged on vital work who cannot utilise alternative grades. Supplies of foundry coke are ample, while scrap is also plentiful on the whole, although consumers are not convinced that present deliveries of scrap will be maintained without still more strenuous efforts being made to bring out fresh material.

Pig-Iron

MIDDLESBROUGH—With local ironmakers busily employed on the manufacture of steelmaking qualities, consumers of foundry iron are denied the opportunity of acquiring their supplies in this district, and all needs are now covered by the Midland furnaces, which are, fortunately, in a position to cope with the additional orders. In normal times, of course, Cleveland foundry iron is bought by consumers in various parts of the country, including Scotland, but the insatiable demands of the steelmakers have compelled iron producers on the North-East Coast to concentrate solely on the manufacture of iron suitable for steel production. Basic iron output is sufficient to cover all demands, but the position regarding hematite is less satisfactory, although a slightly increased production is reported to have materialised recently. No change is reported in the position of heavy engineers. The light foundries are only quietly occupied.

LANCASHIRE—It is permissible now for users of foundry iron to purchase supplies up to the end of January next, licences for this purpose having been handed out. This concession is appreciated by the speciality engineers, as they have full order-books, but there is no buying pressure among the light-castings and jobbing foundries, most of which are in need of new business and already have appreciable stocks of iron on hand. Demand for light castings remains at a low ebb, and these works have been unable to secure much in the way of war orders to counteract the reduction in the number of ordinary outlets. Special refined grades of pig-iron are in steady request, but forge iron is quiet.

MIDLANDS—The products of heavy engineers and machine-tool makers are fully absorbed by Government contracts, and there is no sign that there will be any falling away in these requirements for a long time to come. In fact, the despatch of various machines, munitions, etc., to the U.S.S.R. is creating a new urgency in the demand. Supplies of low-phosphorus iron, while not plentiful by any means, are better than they were, and there is a steady flow of deliveries of refined iron to consuming works. Hematite iron is still tight and many users are taking up high-phosphorus qualities, which are frequently suitable as an alternative. The situation of the light foundry trade is deteriorating as the war goes on, as, with the expansion of demand for the products of other sections of the iron industry, outlets for light castings are being curtailed. Consequently, consumption of high-phosphorus iron in this trade is quiet; ample tonnages are available, however, and many works' stocks are at a high level.

SCOTLAND—Pig-iron requirements are being met fairly satisfactorily in this area, although few consumers have stocks of any size. Heavy engineers and marine founders are absorbing very large tonnages, but demand from the light-castings foundries reflects the quiet conditions now ruling at the majority of the works in this section. Basic iron for the steel trade is in good supply, but hematite is difficult, while some works could do with better deliveries of scrap.

Coke

Current deliveries of foundry coke are quite sufficient to meet all needs, and there is a surplus which is being used to augment consumers' reserves, which are already substantial. So long as deliveries keep reasonably steady, there is no cause to believe that supplies throughout the coming winter will be other than satisfactory.

Steel

The position of the British steel industry after more than two years of war is very gratifying, as, despite the inevitable reduction in American exports to this country, our production is proving sufficient to cope with the insistent pressure for supplies. It has been necessary for the industry to make widespread changes in productive methods, owing to the large quantity of alloy steel needed for the munitions programme. Increased capacity has been allocated to the manufacture of these descriptions at the expense of other grades. Consequently, changes have had to be made in distribution all round.

Scrap

Most steelmakers are receiving adequate deliveries of scrap for current use, but they continue to express the desirability of pressing with greater vigour the collection programme, as they realise that their demands will, if anything, tend to expand. Steelmakers obviously appreciate the necessity for bringing out all supplies of old metal, and it is to be hoped that the responsible authorities will not hesitate to use their full powers where required to add to the nation's resources in this respect. The fact that some scrap consumers are at present having to suspend temporarily further deliveries must not be permitted to influence plans for the future.

Metals

COPPER—In this country manufacturing concerns using copper are tackling as much work as they can accommodate, and it is gratifying that supplies of the red metal are sufficient to enable consumers to operate so fully. Demand for copper in connection with our own armament programme is intense, while the Government's policy of giving all possible aid to the Soviet Union is bound to increase appreciably the pressure on our resources. It is certain that the supply position in the United Kingdom has improved very considerably in recent months, and the wise course adopted by the Control in permitting supplies to go to essential users only will be fully upheld now that it has become necessary to export the metal. Copper is also being sent to the U.S.S.R. from the United States, where the need for economy in the use of the metal is proved by the steps to curtail consumption which have recently been announced.

TIN—Stocks of tin in this country tend to increase, and all requirements are being met satisfactorily. Prices on the London Metal Exchange have moved within narrow limits. The tinplate trade here has been affected by the concentration of industry plans, so that tin consumption by this industry has fallen away considerably. In the United States, however, output of tinplates remains at a high level. Stocks of tin in America must by now be substantial and it is likely that most of the larger consumers have considerable reserves on hand.

Russian tin purchases in the Singapore market have rather upset conditions there, prices going against other customers of the producers. Since the German war on the Soviet Union commenced Russian buyers have taken up large tonnages of tin, and other consumers have to a large extent been shut out of the market. It is now announced that future Soviet purchases will be regularised; the programme is understood to provide for the acquisition by Russia of from 1,000 to 1,500 tons a month, according to the extent of her needs. Changes have also been made in the method of purchase; London dealers have been asked to tender between 12.30 and 1 p.m. on days when they receive such invitations for specified amounts to the Non-ferrous Metals Control, which will act on behalf of the Russian Trade Delegation in London as principal. The price in future will be in sterling on the basis of ex works Singapore. This scheme replaces that whereby Russian purchases were made direct from Singapore brokers for shipment.

Two Bills increasing the royalties on tin and tungsten mined in Thailand have been introduced in the Thia National Assembly, with the object of increasing State revenue. The Bills provide for an increase of from 3 to 5 baht, or about 10s., per picul in the royalty on tin ore. In introducing the Bills, the Minister of Economics said that business in tin was in a satisfactory condition.

According to the Statistical Bulletin of the Tin Research Institute, world production of tin in September is estimated at 19,400 tons, compared with 21,800 tons in September, 1940. Production for the first nine months was 185,900 tons in 1941, against 165,400 tons in 1940. United States deliveries totalled 12,715 tons in September, against 13,625 tons in August. U.S. deliveries in the first nine months of the year were 119,287 tons, compared with 81,814 tons in the corresponding period of 1940. Tin consumption of the United Kingdom was 2,079 tons in August last, against 2,418 tons in July and 2,322 tons in August, 1940. World stocks of tin, including smelters' stocks and carryover, decreased by 4,135 tons during September to 46,729 tons at the end of the month, compared with 52,824 tons at the end of September, 1940.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £255 to £255 5s.; Friday, £255 10s. to £255 15s.; Monday, £255 15s. to £256; Tuesday, £256 to £256 5s.; Wednesday, £256 to £256 10s.

Three Months—Thursday, £259 5s. to £259 15s.; Friday, £259 5s. to £259 10s.; Monday, £259 5s. to £259 15s.; Tuesday, £259 15s. to £260; Wednesday, £259 15s. to £260 5s.

SPELTER—Deliveries of spelter to working-up industries continue to be satisfactory, in spite of the shipments being made to Russia. A big demand is received for high-grade metal from brassmakers, but the position of galvanisers has not improved, and consumption of g.o.b. in this trade shows a decline compared with a few months ago. Various efforts are being made in the United States to expand the output of spelter, which is required in ever-increasing tonnages to meet the needs of the defence programme.

LEAD—Demand for this metal is fairly constant and adequate deliveries are being made. Supplies for the building industry are well under the normal level; a certain tonnage is required for military building operations, but this is insufficient to counteract the falling away in ordinary activities.

Sweden's Aluminium Position

Owing to the difficulty of importing aluminium it has been decided to build two more aluminium works in Sweden to raise annual output to 5,000 tons in order to cover the increasing requirements of the Swedish armed forces and industry. Current Swedish capacity is about 2,000 tons of aluminium a year. The rise in general industrial production of Sweden required the import of 3,000 tons of aluminium in 1937 and 4,700 tons in 1938.

New England Foundries

Most of the smaller New England foundries have been able to secure a considerable amount of defence business, so that the continuity of their operations is brighter than that of some larger competitors. Some of the latter are connected with textile machinery or stove and heating equipment companies, and while a portion of the output of such companies may rate a good preference rating, much of it is at the bottom of the list. Efforts by some companies to share in defence work are bearing fruit in a few cases. One of the largest is building a new plant which will turn out machine tool parts. Several of them have subcontracted small portions of their manufacturing space for tools having a high priority. The outlook at present is that there will not be so many plants completely closed by the priority difficulty on pig-iron, as there will be foundries and shops operating part time because their defence business will entitle them to only a percentage of their total iron needs.